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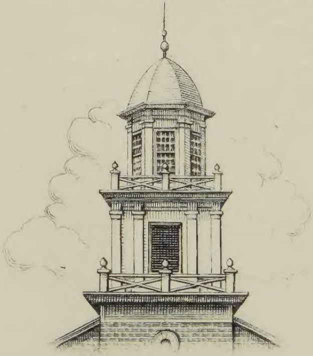

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The Life Forms of Connecticut Plants and Their Significance in Relation to Climate

By

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FOREWORD

The subject of life form is one of large importance in its bearing on the relationship between plants and the conditions under which they live. The basic idea of this relationship is familiar to even the general student of plant life, but its detailed study in an attempt to correlate various features of life form with different features of environment is a comparatively recent development dating back scarcely more than half a century. Until very recently practically all the serious work along this line has been carried on in Europe, and even now the studies of life form by American investigators are very few in number. Recent studies have demonstrated that the nature of the climate in any region is very closely correlated with the abundance of particular plant life forms in that region, and conversely, that the so-called life form "spectrum" for a region affords a very reliable indicator of the character of the climate.

In the present volume an attempt has been made to analyze the flowering plants of Connecticut with reference to life form. Analyses of the floras of various other parts of eastern North America have also been made for the purpose of showing the climatic relationships between the flora of Connecticut and that of other regions. To a large extent the studies have been carried on in the field, but for a considerable number of plants it has been necessary to work out the life forms from the study of herbarium material and from published descriptions.

This problem was suggested to the author by Professor G. E. Nichols of the Botany Department of Yale University and has been worked out under his direction. To him I wish to express my thanks for his constant interest and helpful criticism. I wish also to express my appreciation to Mr. E. H. Eames and Mr. C. A. Weatherby for aid in determining the life form of certain plants.

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Life Forms of Connecticut Plants and Their Significance in Relation To Climate*

By Beulah Ennis, Ph.D.

I. INTRODUCTION

A Historical Survey of the Evolution of Life Form Systems

The ability of any plant to survive is dependent upon its being adapted to the conditions of its environment. This is one of the most obvious and fundamental rules of modern plant ecology. In the earliest times adaptive features were recognized and used in various systems of plant classification, although the significance of the relation existing between plants and their environment was not clear. A brief review of the work of certain botanists shows this early recognition and its continuing growth in the development of the life form idea.

In any historical review of the subject of botany, the first name that confronts the student is that of Theophrastus of Eresos (371-286 B.C.). This famous pupil of Aristotle attacked all phases of his subject with the true spirit of research, constantly enquiring, "What is its difference?" "What is its essential nature?" "What are the characteristic features in virtue of which a plant may be distinguished from other plants?" (Hort, 1916, p. xviii.) As a primary basis of plant classification, Theophrastus recognized the division into trees, shrubs and herbs. His further classification was based on various features in the external form and structure of the plant—features which go to determine what may be designated its physiognomic form. By present day botanists these features are recognized as being essentially of two sorts: features which are of taxonomic importance in distinguishing plants from one another, and features which are of ecological importance in adapting plants to their environment. Consciously or unconsciously this distinction between taxonomic form and ecological form seems to have been recognized by Theophrastus when he says:

> "Indeed all things grow well in congenial places . . . . For even among those of the same kind those which grow in congenial places have less knots, and are taller and more comely; thus the silver fir in Macedon is superior to other silver firs, such as that of Parnassus. Not only is this true of all these, but in general the wild woodland is more beautiful and vigorous on the north side of the mountain than on the south." (l. c., p. 63)
>
> "Such differences would seem to give us a kind of division into classes, for instance, between that of aquatic plants and that of plants of the dry land . . . . . For there are some plants which cannot live except

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*A dissertation presented to the Faculty of the Graduate School of Yale University, in candidacy for the Degree of Doctor of Philosophy.

in wet; and again these are distinguished from one another by their fondness for different kinds of wetness; so that some grow in marshes, others in lakes, others in rivers . . . . . even of these some are impartial and as it were amphibious." (l. c., p. 31)

Thus it is clear that while Theophrastus regarded classification in botany from the standpoint of taxonomy, he recognized the influence and shaping power of environmental conditions.

From Theophrastus up to the time of Linnaeus (1707-1778) all physiognomic characters were used more or less indiscriminitely as a basis of classification. Linnaeus himself was perhaps the first clearly to distinguish between those features which are of primary importance in taxonomic classification and various other features which occupy a position of minor consideration. His work had to do largely with taxonomic characters. It remained for Humboldt (1805) to direct attention to the physiognomic aspects of vegetation in relation to geographic distribution.

Humboldt, the father of geography, perceived that while the species in various parts of the world are different, there are certain forms of vegetation which are common throughout the world. He sought to express to his readers the features of the vegetation of unfamiliar regions by comparing them with those of the regions with which they were familiar. Conifer form meant to them a very definite thing, as did also palm form, fern form, grass form, liane form, etc. These and other similar terms he used in making his seventeen groups into which he considered all the mass of vegetation might be placed. While the terms which he employs are taxonomic, his system of classification seems not really based on taxonomic relation, but rather on physiognomic resemblance. This system formed the basis of all classification of regional vegetation during the next eight decades. Its chief exponents, Grisebach (1872) and Reiter (1885), introducing further features of ecological importance, increased the number of vegetative forms almost three-fold.

In these earlier systems, little distinction was made between those features which are adaptive and those which are not. This distinction was first made by Warming (1894) who laid emphasis on the form of plants as adaptive.

Warming (l. c., p. 2) recognizes the fact that "every species must be in harmony as regards both its external and internal construction with the natural conditions under which it lives." The form which the vegetative body of the plant produces as the result of all the life processes which play on it from the time of its germination until its death, he designates its "vegetation form" or "growth form." The relation between these forms and taxonomic form he makes evident when he says (l. c., p. 5) "Just as species are the units of systematic botany, so are growth forms the units in ecological botany." While these units are usually distinct, he finds that there are cases in which ecological grouping runs parallel with systematic. In his classification of growth forms, he makes six main groups—(1) Heterotropic, (2) Aquatic, (3) Muscoid, (4) Lichenoid, (5) Lianoid, (6) All other autonomous land plants. The sixth class he subdivides with respect to length of life, position of the renewal buds, size of the plant, etc. The terms which he employs show the influence of taxonomy and physiognomy. Indeed it is quite plain that his third, fourth and fifth groups are not wholly ecological. However, his work is of far-reaching value since it brought plant ecology to the rank of a distinct branch of botanical science.

Drude (1913) sets forth a phylogenetic system in which he employs the ecologically important members of the systematic groups as the basis of his classification of plant form. He makes three primary divisions—I. Aerophytes, II. Water plants, III. Mosses and Thallophytes, in which he distinguishes fifty-five types and many sub-types designated as life forms. This system has the advantage of being carefully drawn on ecological principles, but its strict ecological aspect is obscured by the use of taxonomic and physiognomic terms, and the whole is rendered clumsy by the excessive number of types.

The system of Pound and Clements (1898) adapts the earlier system of Drude (1896) making seven main divisions—woody plants, half shrubs, pleiocyclic herbs, hapaxanthous herbs, water plants, hysterophytes, thallophytes, with thirty-four sub-types. Later, Clements (1920) in his work on plant indicators decides that the most useful and consistent aspect of life form is obtained from the point of view of the dominant and subdominant vegetation. Accordingly, he recognizes as four co-ordinate groups annuals, biennials, herbaceous perennials and woody perennials. This is a simple, compact system closely resembling, as Clements himself points out (l. c., p. 63), the original classification of Drude.

Raunkiaer (1905) makes his classification on the adaptive features of plants which enable them to live through the unfavorable season, thus differing from his predecessors who, though recognizing this as significant, use it merely as auxiliary to the main divisions of their systems. He considers of primary importance the position of the perennating buds with respect to the substratum, pointing out that with reference to this character there are four groups of perennial plants—the group in which the perennating buds are well above the surface of the ground; that in which they are just above the surface; that in which the buds are within the surface layer of the soil; that in which they are well beneath this surface layer. These four groups together with that made up of plants which pass the winter in seed form, constitute his five chief divisions. The underlying aim of Raunkiaer's system is to work out a scheme for stating the relation between climate and vegetation. The fact that this is done by means of statistical data is of considerable advantage. Furthermore, the simplicity of the system and its consistent terminology give it claims to being the best that has been set forth up to the present time. As Raunkiaer's system has been adopted in the classification of the plants of Connecticut, it will be considered more in detail in another section. Each of the major divisions will be taken up, subdivisions indicated and illustrative examples given from the Connecticut flora.

Gams (1918) presents a classification of both animals and plants. In accounting for this treatment he says that one can exclude the animal kingdom only if he considers the method of getting nourishment and the consequent division into autotropic and heterotropic organisms as the highest principle of division. In that case he excludes also fungi and chlorophyll-free algae and flowering plants. He considers the relation to habitat most important and accordingly takes this as the primary basis of division. His chief groups are—(1) the attached type, (2) the rooted type and (3) the free type. His secondary division is also based on habitat relations, except in the rooted type where he agrees with Raunkiaer in giving precedence to the position of the perennating bud. His third division is made with respect to food relations. Gams has attempted to bring together the best points of all existing systems. He has formulated his principles of division carefully and has made his classification as concise as possible while including all living organisms; but he uses a terminology which renders his system impractical if not impossible. The inclusions of animals is of doubtful advantage.

In concluding this general survey, it seems advisable briefly to summarize the aspects of plant form which have been emphasized in the different stages of botanical study, showing how they have contributed to the development of the modern conception of life form. The first concept of plant form was taxonomic. While adaptation to environment was doubtless recognized, it played no distinctive part in classification, for all physiognomic features were regarded as equally important. An advance in the understanding of the true significance of the various features of the plant came when certain features of plant form and structure came to be recognized as of primary taxonomic importance while various other features were of minor importance. This is the foundation of our modern conception of taxonomic form. The need of a system of general terms by which the vegetation of a region may be described and related to other regions, brought forth the new idea that all plants tend to group themselves according to certain types of physiognomic form. These types are termed vegetation forms. Finally certain features of a plant came to be recognized as more important in adapting it to its environment than various other features. So far as peculiarities in form and structure of a plant adapt it to meet the conditions of its environment, these are most evidently expressed in what is called the life form. In other words as stated by Nichols (1923, p. 13), "Life form is the visible expression of those features in a plant which determine its adaptation to environment."

The Life Form System of Raunkiaer Considered in Detail

The system of Raunkiaer as stated above is based on the adaptive features of plants which enable them to live through the unfavorable season. The varying position of the perennating bud with reference to the substratum, he makes the basis of his five main groups—Phanerophytes, Chamaephytes, Hemicryptophytes, Cryptophytes, Therophytes. These groups may be briefly characterized as follows: *Phanerophytes* have their perennating buds on branches which are some distance above the ground. They include trees and shrubs and various tropical herbs. *Chamaephytes* have their buds on branches which are near the surface of the ground (not more than 25 cm. above). *Hemicryptophytes* are herbaceous plants which live through the unfavorable season by means of perennating buds located in the surface layer of the soil. *Cryptophytes* are herbs in which the perennating buds are located beneath the surface, at a depth varying according to the species. *Therophytes* are annuals which perennate by means of seed.

I. PHANEROPHYTES

Phanerophytes are most abundant in regions always warm and moist. Here they require no bud protection and are evergreen the greater part of the year. They are also characteristic of subtropical regions where the dry season is not too prolonged and of temperate regions where the climate is not extremely rigorous. In such regions only those plants with a structure adapted to the unfavorable season can survive. The portion of the plant most liable to injury is the embryonic region of the bud. Protection for this may be secured by a covering of bud scales or by changes in the structure and position of the bud. The plant may secure added protection from desiccation by shedding its leaves.

Raunkiaer considers as factors of primary importance (1) presence or absence of bud scales, (2) fall of leaves, (3) decrease in size of plant. Accordingly he uses these three characteristics in making his principal divisions.

With respect to bud scales and the presence or absence of leaves, he has made three divisions:

1. Phanerophytes evergreen without bud cover
2. “ “ with “ “
3. “ deciduous “ “ “

With respect to size he has suggested four divisions:

1. Megaphanerophytes—plants over 30 M. in height
2. Mesophanerophytes— “ 8–30 M. “ “
3. Microphanerophytes— “ 2– 8 M. “ “
4. Nanophanerophytes— “ under 2 M. “ “

Combining these two series he distinguishes twelve classes, to which he adds three groups based on characters other than those specified—phanerophytic herbs, phanerophytic epiphytes and phanerophytic stem succulents. These fifteen he arranges in a series, according to their progressive protection.

These classes are as follows:

1. Phanerophytic herbs
2. Evergreen megaphanerophytes without bud cover
3. “ mesophanerophytes “ “ “
4. “ microphanerophytes “ “ “
5. “ nanophanerophytes “ “ “
6. Phanerophytic epiphytes
7. Evergreen megaphanerophytes with bud cover
8. “ mesophanerophytes “ “ “
9. “ microphanerophytes “ “ “
10. “ nanophanerophytes “ “ “
11. Phanerophytic stem succulents
12. Deciduous megaphanerophytes with bud cover
13. “ mesophanerophytes “ “ “
14. “ microphanerophytes “ “ “
15. “ nanophanerophytes “ “ “

More than nine tenths of the phanerophytes of the Connecticut region are decidous. Of the evergreens, the majority are conifers having linear or scale-like leaves. The broad-leaved evergreens are as follows:

Ilex opaca
“ glabra
Rhododendron maximum
Kalmia latifolia
Kalmia angustifolia
“ polifolia
Andromeda glaucophylla

The conifers are mostly tall trees, the broad-leaved evergreens small trees or shrubs. Microphanerophytes are most abundant, but the difference in number of species between these and the groups of higher and lower stature is not great. *Opuntia vulgaris* is the only succulent phanerophyte in the Connecticut flora; in this region its height usually corresponds more nearly to that given for chamaephytes. *Arceuthobium pusillum*, a herbaceous parasite, is included in the group of phanerophytic epiphytes.

II. CHAMAEPHYTES

Chamaephytes are most abundant in regions which have a long winter, but are characteristic also of the moist tropics and occur in temperate and arid regions. Their distinguishing feature is that they have a perennial shoot above ground with buds borne less than 25cm. above the surface. Their habit of growth is of three sorts: upright shoots which die back nearly to the surface of the ground during the unfavorable season; prostrate shoots which are perennial throughout; low erect shoots which grow in dense clusters. Those of the first group are called *semi-shrubby chamaephytes*; those of the second, *passive chamaephytes* if the tip of the stem is erect, *active chamaephytes* if entirely prostrate; those of the third group are called *cushion plants.*

Semi-shrubby chamaephytes are most abundant in temperate regions which have a prolonged dry season. There are only a few in the Connecticut flora. Among these, *Iva oraria* makes a transition to nanophanerophytes; *Potentilla tridentata* and *Aralia hispida* to hemicryptophytes. *Decodon* is a swamp plant with a semi-shrubby habit. The small green buds which are covered by a spongy-thickened bark are usually further protected by being submersed during the winter. With the semi-shrubby chamaephytes there belong a few low plants whose shoots do not die at the approach of the unfavorable season and which do not form cushions. *Hudsonia* spp., which have been classed as passive chamaephytes, might more properly be cited as examples of this group.

Active and passive chamaephytes are characteristic of regions in which the unfavorable season is represented by winter. During this season the shoots are usually protected from cold and desiccation by a blanket of snow. They may be evergreen or deciduous, woody or herbaceous. The following are examples from the Connecticut flora.

Passive Chamaephytes:

Arenaria stricta
" groenlandica
Cerastium arvense
Vaccinium Oxycoccos
" macrocarpon
Hudsonia tomentosa
Hudsonia ericoides
Antennaria plantaginifolia
" fallax
" neodioica
" neglecta
Veronica officinalis

Active Chamaephytes:

Epigaea repens
Chiogenes hispidula
Linnaea borealis
Arctostaphylos Uva-ursi
Mitchella repens

Cushion plants grow in such crowded colonies that they give support to each other, as is the habit of many of our mosses. When they grow in very compact tufts, there results for the perennating vegetative part, a protection similar to that given hemicryptophytes by the vegetative parts situated at the surface of the ground. These forms, therefore, may be considered intermediate between cushion plants and caespitose hemicryptophytes. There are no cushion plants in the Connecticut flora.

III. HEMICRYPTOPHYTES

Hemicryptophytes are characteristic of temperate climates where the dry season is not too prolonged. In such regions they constitute about half the species of the flora. Though the aerial shoot dies entirely at the beginning of the unfavorable season, life is carried on from year to year by the subterranean organs. The lower parts of many hemicryptophytes form a system of ramifications beneath the surface of the ground analogous to that formed by chamaephytes above ground.

Hemicryptophytes vary greatly in the form of both the aerial and subterranean parts. They have been subdivided first with reference to the character of the aerial shoot. Certain plants have all the leaves as well as the floral shoots on the stem, thus being similar to phanerophytes. These are called *protohemicryptophytes.* Some have a basal rosette of leaves with smaller leaves on the stem which bears the flowers. These are called *semi-rosette plants.* Others have all of the leaves in a basal rosette, the stem serving only to bear the flowers. These are called *rosette plants.*[1] Further subdivision of the group is made on the basis of the presence or absence of running branches.

Protohemicryptophytes without running branches. Examples from the Connecticut flora as follows:

Baptisia tinctoria
Desmodium canadense
Lespedeza hirta
“ capitata
Hibiscus Moscheutos
Hypericum mutilum
Helianthemum canadense
“ majus
Lechea villosa
Gentiana Andrewsii
Asclepias incarnata
Verbena urticaefolia
Verbena hastata
Chelone glabra
Gerardia flava
“ virginica
Vernonia noveboracensis
Eupatorium verbenaefolium
Solidago speciosa
Helenium autumnale
Hieracium paniculatum
“ scabrum
“ canadense

Protohemicryptophytes with running branches. Examples from the Connecticut flora as follows:

Maianthemum canadense
Smilax herbacea
Rubus occidentalis
“ allegheniensis
“ hispidus
“ villosus
Agrimonia gryposepala
“ mollis
“ rostellata
Hypericum punctatum
“ ellipticum
“ virginicum
Ludvigia palustris
Aralia nudicaulis
Aralia racemosa
Cornus canadensis
Chimaphila umbellata
“ maculata
Gaultheria procumbens
Lysimachia quadrifolia
“ terrestris
Steironema ciliatum
Trientalis americana
Scutellaria lateriflora
Lycopus virginicus
“ uniflorus
“ americanus
Mimulus ringens

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[1] This subdivision takes no account of winter characters, which, with this exception, are used consistently as the basis of classification. Protohemicryptophytes can usually be distinguished from the other two groups in winter since in them the entire aerial plant dies but there are certain transitional forms as *Epilobium coloratum*, *E. adenocaulon*, *Steironema*, etc. which combine the summer leaf arrangement of protohemicryptophytes with winter rosettes. Rosette and semi-rosette plants, however, both of which have a basal rosette that persists throughout the winter, can not be distinguished from one another at this season. This subdivision, therefore, is inconsistent with the system. It seems also of comparatively little importance.

Solidago odora
“ rugosa
“ aspera
“ altissima
“ graminifolia
“ tenuifolia
Aster patens
“ multiflorus
“ paniculatus
“ novi-belgii
Aster puniceus
“ umbellatus
“ linariifolius
“ acuminatus
Anaphalis margaritacea
Rudbeckia laciniata
Helianthus divaricatus
“ strumosus
“ decapetalus

This last group of hemicryptophytes presents such variety in the form of its running branch that it has seemed to deserve particular comment. Certain species, as *Lysimachia quadrifolia*, *Steironema ciliatum* and *Anaphalis margaritacea*, have long subterranean runners. The new plant, developed the second season from the bud at the surface, becomes distinct from other parts of the system by the decay of the underground runners. The mother plant dies. Other plants, as *Aster* spp., *Solidago* spp., produce short underground runners and tend to form clumps. Still others, as *Aralia racemosa*, and *Smilax herbacea* produce buds about an inch in length from thick rhizomes which grow near the surface of the ground. *Rubus* spp. are unique among hemicryptophytes in having a woody aerial part. They are classed as hemicryptophytes rather than chamaephytes or phanerophytes because the life of the individual plant is dependent on buds located at the surface rather than on the aerial shoots which are biennial. The stems of the greater number of *Rubus* spp. bend over and may take root where the extremities touch the soil. In such cases a perennating bud is formed in the surface layer of the soil.

Hemicryptophyte semi-rosette plants without running branches. Examples from the Connecticut flora as follows:

Andropogon scoparius
“ furcatus
Aristida purpurascens
Muhlenbergia Schreberi
Agrostis perennans
Eragrostis pectinacea
Elymus virginicus
Hystrix patula
Carex scoparia
“ stellulata
“ stipata
“ stricta
“ virescens
“ pallescens
“ laxiculmis
“ digitalis
“ laxiflora
“ intumescens
Rumex Britannica
Ranunculus abortivus
“ recurvatus
Thalictrum dioicum
“ polygamum
Anemone virginiana
Caltha palustris
Aquilegia canadensis
Barbarea stricta
Parnassia caroliniana
Potentilla monspeliensis
Geum canadense
“ virginianum
Linum striatum
“ virginianum
Oenothera biennis
“ pumila
Sanicula marilandica
Osmorhiza longistylis
Zizia aurea
Limonium carolinianum
Prunella vulgaris
Linaria canadensis
Artemisia caudata
Senecio aureus
Cirsium pumilum
Prenanthes trifoliolata
Hieracium venosum
“ Gronovii

In many of the plants of this foregoing list, rosettes of leaves grow up from the old stalk in autumn. Here belong also the greater number of biennial plants as *Ranunculus abortivus*, *Oenothera biennis*, *Artemisia caudata*, *Lactuca* spp., *Cirsium* spp.

A few bog plants have an interesting habit of growth. The perennating bud formed at the surface in autumn is often buried by the growth of sphagnum. At the renewal of the growing season, the buried bud sends up a vertical rhizome which produces a tuft of leaves at the surface. Such plants are *Eriophorum callitrix*, *Rynchospora alba*, *Carex trisperma*, *C. diandra*, *C. paupercula* var. *pallens*.

Hemicryptophyte semi-rosette plants with running branches. Examples from the Connecticut flora are as follows:

Sorghastrum nutans
Hierochloë odorata
Muhlenbergia mexicana
Spartina Michauxiana
Rynchospora glomerata
Carex leptalae
  “ lupulina
Ranunculus Cymbalaria
  “ septentrionalis
Potentilla argentea
  “ pacifica
  “ pumila
  “ canadensis
Geranium maculatum
Solidago bicolor
  “ sempervirens
  “ neglecta
  “ nemoralis
Aster divaricatus
  “ Schreberi
  “ macrophyllus
  “ laevis
Erigeron pulchellus
  “ philadelphicus
Achillea Millefolium

The majority of the plants of this group have subterranean running branches. The following have aerial runners: *Ranunculus Cymbalaria*, *R. septentrionalis*, *R. repens*, *Potentilla argentea*, *P. pacifica*, *P. pumila*, *P. canadensis*.

Hemicryptophyte rosette plants without running branches. Examples from the Connecticut flora as follows:

Xyris caroliniana
  “ flexuosa
Spiranthes gracilis
Liparis Loeselii
Hepatica triloba
Sarracenia purpurea
Drosera rotundifolia
  “ longifolia
Plantago major
  “ Rugelii
  “ decipiens

The plants of the preceding group may develop new rosettes of leaves within the old ones, as in *Hepatica* spp., or may produce offsets from the old stem as in *Spiranthes*. A few are biennials—*Plantago virginica* and *P. elongata*. *Liparis Loeselii* has a bulb which comes up above the surface of the ground, thus being a transitional form between hemicryptophytes and bulb geophytes.

Hemicryptophyte rosette plants with running branches. Examples from the Connecticut flora as follows:

Epipactis repens
Coptis trifolia
Fragaria virginiana
  “ vesca var. americana
Oxalis Acetosella
Viola cucullata
  “ nephrophylla
Viola papilionacea
  “ pallens
Hydrocotyle americana
Pyrola elliptica
  “ americana
Petasitis palmatus

Considerable diversity in habit of growth is exhibited by the species of the preceding group. *Pyrola* spp. are evergreens with the general appearance of chamaephytes. They differ from chamaephytes in that the bud on the aerial shoot is only a flower bud instead of a means of continuing the life and growth of the plant. In this group growth is continued by means of subterranean runners which produce buds at the surface of the ground. The second season the bud produces a rosette of leaves; the third season a flower stalk is developed. *Viola* spp. have thick oblique rhizomes which produce buds at the surface of the soil. *Fragaria* has aerial stolons.

IV. CRYPTOPHYTES

Cryptophytes are divided into two groups; those plants which have their perennating buds located at a fixed distance beneath the surface of the soil, essentially land plants, and those which grow always or preferably in water. Those of the first group are called *geophytes*; those of the second *helophytes* if the leaves and floral shoots emerge, *hydrophytes* if all the vegetative organs are immersed.

Geophytes are characteristic of regions having a prolonged dry season, and also of regions which have a prolonged cold season. On the basis of the type of subterranean organ, they are subdivided into the following classes: *Rhizome geophytes; Stem tuber geophytes; Bulb geophytes; Root tuber geophytes; Root geophytes*. The characteristics of these groups are discussed below in their respective sections.

The term rhizome geophyte is self explanatory. Examples from the Connecticut flora are as follows:

Panicum amaroides
“ virgatum
Setaria imberbis
Phalaris arundinacea
Phragmites communis
Distichlis spicata
Eleocharis acicularis
“ tenuis
Scirpus americanus
Eriophorum gracile
Carex rosea
“ cephalophora
“ pennsylvanica
“ conoidea
“ vestita
Symplocarpus feotidus
Juncus Gerardi
“ canadensis
Veratrum viride
Uvularia perfoliata
Smilacina racemosa
“ stellata
Polygonatum biflorum
“ commutatum
Medeola virginiana
Trillium erectum
“ cernuum
“ undulatum
Aristolochia Serpentaria
Arenaria peploides
Anemone quinquefolia
Cimicifuga racemosa
Actaea rubra
“ alba
Sanguinaria canadensis
Dentaria diphylla
Polygala Senega
Circaea lutetiana
Asclepias syriaca
Collinsonia canadensis
Physalis heterophylla

Veratrum viride has a short thick rhizome which bears a large bud which is comparable to a bulb in size and structure. It may be considered as intermediate between rhizome and bulb geophytes.

Stem tuber geophytes include several different forms. Most abundant are those with a single tuber or corm as *Arisaema triphyllum*, *Liatris scariosa*, *Claytonia caroliniana*, *C. virginiana*, *Dentaria laciniata*, *D. anomala*, *Panax trifolium*, *P. quinquefolium*. In *Dicentra Cucullaria*, a cluster of very small grain-like tubers make up a scaly bulb. *Dicentra canadensis* and *Arisaema Dracontium* have clusters of tubers or corms. *Scutellaria parvula* and *Apios tuberosa* have subterranean stolons which are moniliform tuberiferous. In *Cardamine bulbosa* and *C. Douglassii* small tubers are borne on a very slender rootstock. *Cyperus esculentus* has many tubers which often spread the plant so extensively as to become a pest in cultivated ground.

Bulb geophytes are rare in this region. Examples from the Connecticut flora are as follows: *Allium tricoccum*, *A. canadense* *Lilium philadelphicum*, *L. superbum*.

In root tuber geophytes, there is left alive during the unfavorable season only one or more tuberous roots. *Heracleum lanatum* has a long, deeply set parsnip-shaped root. *Phytolacca decandra* has a broad tuberous root. *Orchis spectabilis*, *Habenaria spp.*, *Pogonia ophioglossoides*, *P. verticillata*, *Anemonella thalictroides* have clustered tuberous roots which separate and may each produce a new plant the next season.

Root geophytes differ from root tuber geophytes in that the perennating buds are located on fibrous roots instead of on tuberous roots. *Monotropa* spp. are examples of this group. Plants which are normally hemicryptophytes may in extremely unfavorable seasons or circumstances conduct themselves as root geophytes.

The term helophyte does not include all swamp plants, but only those which are cryptophytes. Their perennating buds are situated under water or in saturated soil. The members of this group usually have rhizomes. Examples from the Connecticut flora are as follows:

Typha latifolia
" angustifolia
Sparganium americanum
" diversifolium
Sagittaria latifolia
" graminea
Alisma Plantago-aquatica
Dulichium arundinaceum
Eleocharis palustris
Scirpus Olneyi
" validus
Carex rostrata
Peltandra virginica
Calla palustris
Orontium aquaticum
Acorus Calamus
Pontederia cordata
Juncus militaris
Saururus cernuus
Potentilla palustris
Ludvigia sphaerocarpa
Lysimachia thyrsiflora
Menyanthes trifoliata

Hydrophytes have their persisting buds protected by water. *Nymphaea advena*, *Castalia odorata*, *Nelumbo lutea*, *Brasenia Schreberi*, *Zostera marina* and *Menyanthes trifoliata* have rhizomes. *Ranunculus circinatus*, *R. aquatilis* var. *capillaceus*, *R. delphinifolius*, *Myriophyllum* spp., *Bidens Beckii*, *Ruppia maritima*, *Zannichellia palustris*, *Najas flexilis*, *Elodea canadensis*, *Vallis-*

neria spiralis, *Ceratophyllum demersum*, *Sparganium minimum* and certain species of *Potamogeton* have perennial stems which function as rhizomes. In some plants the vegetative body dies entirely, leaving alive only certain buds which sink to the bottom of the water to spend the winter. Some of these (*Potamogeton zosterifolius*, *P. mucronatus*, *P. obtusifolius*, *P. pusillus*, etc.) take root; others remain floating. Of these last *Spirodela* and *Lemna* have roots, *Utricularia* and *Wolffia* do not.

V. THEROPHYTES

Therophytes are plants which carry out their life cycle in the course of the favorable season and which spend the unfavorable season resting in the form of seed. They are characteristic of regions which have a relatively short growing period, as deserts and other regions which are hot and dry. To this class is added certain plants which germinate in the autumn and carry out their life cycle in the winter rather than in the summer.

Relative Distinctness of Different Forms and Intergradations

In devising this system of life forms, Raunkiaer has given particular attention to the choice of characters which can be easily distinguished. For the most part, he has succeeded very well. Phanerophytes, chamaephytes, geophytes, hydrophytes, therophytes and their respective subdivisions can usually be recognized with little difficulty. Typical hemicryptophytes are easily distinguished but the lines of division between them and several other groups are not very sharp.

The relation between protohemicryptophytes and semi-shrubby chamaephytes has already been pointed out. In such plants as *Oxalis stricta*, in which the bud may be raised a short distance above the surface of the ground, there may be a question as to which class they belong.

In the discussion of helophytes it was emphasized that this group includes only those swamp plants which are cryptophytes. Plants with hemicryptophyte habit often grow in the margins of lakes and streams. Normally these are not helophytes; but in unfavorable seasons when the buds at the surface die and the plants live by means of buds situated below the surface of the ground, they conduct themselves as helophytes. Again, the surface buds of hemicryptophytes may be killed if the plants are submerged in winter. These plants are called facultative helophytes. Rhizome cryptophytes which may grow in fairly dry soil or in standing water are classed as geophytes rather than helophytes.

Hemicryptophytes with running branches as Solidago spp., etc., may be mistaken for geophytes. The distinction between these groups is not hard to make if one remembers that the running branches of geophytes are parallel to the surface of the ground, while those of hemicryptophytes bend upward, placing the bud at the surface.

Biennials, all of which are classed as hemicryptophytes, may be confused with the small group of therophytes known as winter annuals, plants which germinate in the autumn and pass the vegetative period in the winter instead of in the summer. The life cycle of winter annuals is carried out during two years as is that of biennials. They differ from biennials in the time of germination and the length of their growing period.

Due to climatic or physiographic diversity, a plant may not always belong to the same class or subclass. A semi-shrubby chamaephyte, being intermediate between protohemicryptophytes and nanophanerophytes, might belong to either of these two classes in regions with a climate more or less rigorous. Even seasonal variation may determine whether buds remain alive above the ground, at the surface or below the surface. The difference in the response made by the same species growing in two different regions should be of advantage in comparing the climates of these regions.

Various Applications of the Life Form Idea to the Study of Vegetation

As an indicator of the ecological adaptiveness of the plant, the life form idea is capable of many applications in the study of vegetation. It furnishes a means, for example, by which vegetation may be analyzed with reference to its ecological rather than its taxonomic affinities. This analysis naturally falls into two classes. The first, in which the classification is based upon a consideration of the life forms of the *dominant vegetation*, is concerned with the ecological features of this vegetation. Its significance is to furnish a means of arriving at a general idea of the vegetation of any given region—to give as it were, a picture of the plant growth. The second, in which the classification is based upon a consideration of the life forms of *all the species* included in the flora, is concerned with the ecological structure of the vegetation. Its purpose is to furnish a means of arriving at a detailed knowledge of the entire plant growth.

Such a classification as the first forms the basis of the system devised by Brockmann-Jerosch and Rübel (1912) as well as that of a system devised by Raunkiaer (1913). These two systems, though differing in many respects, are fundamentally identical. Their primary divisions are purely physiognomic, being based on considerations of such vegetation aspects as forest, desert, meadow and water plants. Their secondary divisions are truly ecological indicating the evergreen character, the relative height, etc. of the vegetation. It is these secondary divisions with their real use of life form that make these systems of interest in this paper.

Such a classification as the second—that which concerns itself with the life forms of all the species included in the flora, forms the basis of a system earlier devised by Raunkiaer (1908). One special value of this system is that it lends itself to statistical handling. Raunkiaer determines the actual number of species of his seven life forms in a given region and then mathematically states their numerical relationship to each other in terms of percentage. Thus, a region might be found to have, as constituents of its flora, 23% phanerophytes, 4% chamaephytes, 55% hemicryptophytes, 10% cryptophytes, 8% therophytes. To this reduction of any definite flora to a sequence of mathematical percentages, Raunkiaer has given the name of ecological spectrum.

It is obvious that by the use of a spectrum so obtained the flora of a region can be briefly and accurately presented in statistical form. Moreover, it is also obvious that, spectra of different regions having been acquired, this system gives a fair means of comparing the flora of the regions represented by these spectra. Furthermore, as will be later pointed out, results furnished by the spectra supply means for a fairly accurate account of the plant climate of regions whose spectra have been made.

The most notable work done in preparing spectra of regions is naturally that by Raunkiaer. He has made a complete spectrum for Denmark as well as incidental spectrum surveys of the Danish West Indies, the French Mediterranean, certain sections in North America, etc. Other workers, recognizing the value of his method, have made use of it in their vegetation studies, notably Vahl (1911, 1912, 1913) for Scandinavia, Noto and Swedish Lapland; Paulsen (1912, 1915, 1920) for the Caspian lowlands, the deserts of America; Simmonds (1912) Swedish Lapland; Harshberger (1914, 1916) Florida Keys, New Jersey pine barrens; Braun (1915) French Mediterranean region; Taylor (1915, 1918) New York, Long Island; McLean (1919) South Brazil.

The second use of the ecological spectrum, that of comparison of different regions as to their flora, is a natural corollary to the first. After having obtained the spectra of two regions, the inevitable next step is a comparison of these spectra. Two such spectra, posed side by side, give at a glance the definite plant relationship of the two regions as to the percentages of life forms represented. For example, Raunkiaer has made a comparison of the vegetation of the Death Valley in western United States with that of Spitzbergen, by juxtaposing their spectra thus:

	No. of Species	F	Ch	H	K	Th
Death Valley	294	26	7	18	7	42
Spitzbergen....................	110	1	22	60	15	2

Immediately one sees that in phanerophytes (F) and therophytes, (Th), the Death Valley outnumbers Spitzbergen, whereas in chamaephytes (Ch), hemicryptophytes (H) and cryptophytes (K), Spitzbergen outnumbers the Death Valley. The character of the vegetation as to its life form is by this statistical means readily conveyed to the reader. Paulsen makes such a comparison between the Caspian lowlands and the Libyan desert. And so with the comparative studies of other ecologists using the spectrum to reveal difference or similarity in the vegetation of the regions compared. So also in this present work, the spectrum of Connecticut has been compared with spectra of other localities—Mississippi, Cape Breton, etc.

Finally, the third use to which the ecological spectrum lends itself is as an indicator of climate. It hardly needs to be said that a plant will grow only in that locality in which it finds itself able to get what it needs for life,—sustenance and protection. Safe-guarded in these two respects, it goes without saying that the plant is able to live and reproduce. Of these elements, sustenance and the part it plays in the structure and activity of the plant, together with the part played by its environment, is mainly a physiological question. As such its consideration has no place in a discussion of the uses of the spectrum. This leaves for present consideration the question of protection and the part it plays in the structure and activity of a plant together with the part played by its environment. It is evident from preceding sections of this paper that the chief means of protection within the power of the plant itself is indicated by its life form characteristics. The fact that a species grows in a certain locality indicates that it possesses life form characteristics that are adapted to the local conditions of environment. It is obvious that, as far as the geographical distribution of plants over large areas is concerned, the outstanding factor of environment is climate. In practically every large region of uniform climate, it is reasonable to expect a diversity of topographic and soil conditions sufficiently great to permit the development in at least some localities of practically all the plants to which the climatic conditions are favorable. Therefore the high or low percentages of certain life forms in the spectrum of a region should be a fair index of the climate of that region. For instance, a high percentage of phanerophytes with a low percentage of cryptophytes should indicate a mild climate for that region; whereas a region with a high percentage of cryptophytes and a low percentage of phanerophytes should indicate severity during the unfavorable season. It must be borne in mind that these percentages are based upon the number of species of the different life forms present in a particular geographic region, not upon abundance of growth of any one species or number of species. Therefore an analysis of the plant life of a region in terms of life form does not necessarily give a picture of the physiognomic features of the vegetation in that region, since that may be influenced by the widespread occurrence of certain features of soil or topography which favor the development of certain life forms and groups of life forms at the expense of others, and also by other conditions and relationships. Furthermore, in comparing different regions in this way, it is of minor consequence that the lists of species differ, since it is life form identity rather than taxonomic indentity which is important. The same life form is exhibited by numerous different species in the same region, and for purposes of ecological comparision it is the number of representatives of different life forms which are significant rather than the taxonomic identity of the plants concerned.

It was in this matter of climate comparison by means of the ecological spectrum that Raunkiaer hit upon the idea of what he calls the "normal spectrum" by which to fix the boundaries of plant climate-zones. This spectrum is, as summarized by Smith (1916, p. 19-20), "the base line, and the outstanding features of the other spectra are deduced by comparison, not by the highest percentage in their own curve, but by the amount of variation from the normal spectrum. The latter is, ideally, the phytoclimatic spectrum of the whole earth; actually, it is obtained by computation, and at present is given only as approximate." It was arrived at by selecting and carefully analyzing one thousand representative species. Evidence deduced from his study of spectra leads Raunkiaer to regard the normal spectrum as a good working hypothesis. His statistics refer as yet only to the Northern Hemisphere, and within this he recognizes three principal regional climate-zones: (A) a tropical area with uniform and high temperatures, but a varying humidity; passing northwards from this we have (B) an area of decreasing warmth correlated with an increasing difference between summer and winter, but with a precipitation suitable at most times for plant life; (C) warmth decreasing from equator to pole as in B, but with decreasing precipitation, at least in summer. These climate zones are characterized as A, B, and C, climate series, respectively. The series suggests three types of climate—phanerophytic, hemicryptophytic and chamaephytic. Summarizing, it thus appears that from the equator northwards, there is a definite series of ecological spectra. The phanerophytes and therophytes develop with warmth, and northwards decrease and disappear. The cryptophytes, although widely distributed, also disappear in the north. The hemicryptophytes reach a maximum in temperate climates where they remain constant at about double the normal spectrum. The chamaephytes increase northward where they are particularly significant.

Purpose of the Following Sections

1. To determine the life forms of the flowering plants of Connecticut, this state being selected as illustrative of the flora of New England.
2. To characterize the climate of this region by the response which the plants make to their surroundings as is exhibited in their life form.
3. To compare the climate of this region as reflected by its vegetation with that of other sections north, south and west of Connecticut with a view to gaining an idea of the plant climate of the eastern portion of North America.

II. STUDY OF THE FLOWERING PLANTS OF CONNECTICUT WITH PARTICULAR REFERENCE TO LIFE FORM

In this section I have recorded by families the life form of all the species of flowering plants in the Connecticut flora. The arrangement and nomenclature follow that of the Catalogue of the Flowering Plants and Ferns of Connecticut," Bulletin No. 14 of the State Geological and Natural History Survey. The number of genera and species given for each family refer to those which are native. Naturalized species are listed separately below the treatment of native species. Those plants given by the Connecticut catalogue as "fugitive", "adventive", or rare escapes from cultivation have not been considered in this work. Varieties of species have not been included unless the life form of the variety and that of the typical species is different. Evergreen species are in bold face type. The symbols used in this section are as follows:

Mg—megaphanerophyte
Ms—mesophanerophyte
Mc—microphanerophyte
N —nanophanerophyte
Ch —chamaephyte
H —hemicryptophyte
G —geophyte
T —therophyte (annual)
bien—biennial
per —perennial

TAXACAE

A family of trees and shrubs represented by one genus, one species: **Taxus canadensis,** nanophanerophyte.

PINACEAE

A family of trees and shrubs represented by eight genera, thirteen species, grouped as follows:

PHANEROPHYTES

MEGAPHANEROPHYTES
- **Pinus Strobus**
- " **resinosa** (Ms)
- **Picea rubra** (Ms)
- **Tsuga canadensis** (Ms)

MESOPHANEROPHYTES
- **Pinus rigida**
- Larix laricina
- **Picea mariana**
- **Abies balsamea**
- **Chamaecyparis thyoides**
- **Thuja occidentalis**
- **Juniperus virginiana**

MICROPHANEROPHYTES
- **Juniperus communis**

NANOPHANEROPHYTES
- **Juniperus communis** var. **depressa**

TYPHACEAE

A family of marsh or aquatic herbs represented by one genus, two species: Typha latifolia, T. angustifolia, helophytes.

SPARGANIACEAE

A family of marsh or pond plants represented by one genus, seven species: Sparganium eurycarpum, S. americanum, S. lucidum, S. diversifolium, helophytes; S. angustifolium, S. fluctuans, S. minimum, hydrophytes.

NAJADACEAE

A family of immersed aquatic plants represented by five genera, thirty-three species, all hydrophytes:

Potamogeton natans
“ Oakesianus
“ epihydrus
“ alpinus
“ americanus
“ pulcher
“ amplifolius
“ heterophyllus
“ angustifolius
“ lucens
“ praelongus
“ Richardsonii
“ bupleuroides
“ nitens
“ zosterifolius
“ Hillii
“ obtusifolius
Potamogeton Friesii
“ pusillus
“ lateralis
“ Vaseyi
“ gemmiparus
“ foliosus
“ confervoides
“ hybridus
“ dimorphus
“ pectinatus
“ Robbinsii
Ruppia maritima
Zannichellia palustris
Zostera marina
Najas flexilis
“ gracillima

JUNCAGINACEAE

A family of marsh herbs represented by two genera, two species: Scheuchzeria palustris, hemicryptophyte semi-rosette plant with running branches; Triglochin maritima, hemicryptophyte rosette plant without running branches.

ALISMACEAE

A family of aquatic or bog herbs represented by three genera, nine species, all helophytes:

Sagittaria longirostra
“ latifolia
“ Engelmanniana
“ arifolia
“ heterophylla
Sagittaria graminea
“ subulata
Lophotocarpus spongiosus
Alisma Plantago-aquatica

HYDROCHARITACEAE

A family of submerged aquatic herbs represented by two genera, two species: Elodea canadensis, Vallisneria spiralis, hydrophytes.

GRAMINEAE

A family of herbs represented by forty-six genera, one hundred fifty-three species grouped as follows:

HEMICRYPTOPHYTES

HEMICRYPTOPHYTE SEMI-ROSETTE PLANTS WITHOUT RUNNING BRANCHES

Tripsacum dactyloides
Andropogon scoparius
“ virginicus
“ furcatus
Leptoloma cognatum
Paspalum setaceum
“ pubescens
“ Muhlenbergii
“ psammophilum
“ plenipilum
“ circulare
Panicum longifolium
“ agrostoides
“ stipitatum
“ depauperatum
“ linearifolium
“ Werneri
“ Bicknellii
“ dichotomum
“ barbulatum
“ microcarpon
“ boreale
“ spretum
“ Lindheimeri
“ huachucae
“ implicatum
“ meridionale
“ oricola
“ subvillosum
“ tennesseense
“ albemarlense
“ scoparioides
“ pseudopubescens
“ villosissimum
“ Commonsianum
“ Addisonii
“ tsugetorum
“ columbianum
“ sphaerocarpon
“ Ashei
“ Scribnerianum
“ xanthophysum
“ aculeatum
“ clandestinum
“ Boscii
“ latifolium
Stipa avenacea
Aristida purpurascens
Muhlenbergia Schreberi
“ capillaris
Alopecurus geniculatus
Sporobolus clandestinus
“ asper
“ cryptandrus
“ heterolepis
“ uniflorus
Agrostis perennans
Cinna arundinacea
“ latifolia
Sphenopholis obtusata
“ nitida
“ pallens
“ palustris
Trisetum spicatum
Deschampsia flexuosa
“ caespitosa
Danthonia spicata
“ compressa
Triplasis purpurea
Eragrostis pectinacea
Melica striata
Poa triflora
“ debilis
“ alsodes
Glyceria Torreyana
“ obtusa
“ canadensis
“ nervata
“ grandis
“ pallida
“ Fernaldii
“ septentrionalis
“ borealis
“ acutiflora
Puccinellia angustata
“ distans
Festuca ovina
“ nutans
Bromus ciliatus
“ purgans
“ altissimus
“ incanus
“ Kalmii
Hordeum jubatum (bien)
Elymus virginicus
“ halophilus
“ australis
“ candensis
“ striatus
Hystrix patula

HEMICRYPTOPHYTE SEMI-ROSETTE PLANTS WITH RUNNING BRANCHES

Sorghastrum nutans
Leersia virginica
“ oryzoides
Hierochloë odorata
Milium effusum
Muhlenbergia sobolifera
“ tenuiflora
“ sylvatica

Muhlenbergia foliosa
“ mexicana
“ racemosa
Brachyelytrum erectum
Agrostis alba
Calamagrostis canadensis
“ cinnoides

Spartina Michauxiana
“ cynosuroides
“ glabra
“ patens
Bouteloua curtipendula
Tridens flavus
Festuca rubra

GEOPHYTES

Rhizome geophytes

Panicum amaroides
“ virgatum
Setaria imberbis var. perennis
Oryzopsis pungens
“ asperifolia

Oryzopsis racemosa
Phalaris arundinacea
Ammophila arenaria
Phragmites communis
Distichlis spicata

THEROPHYTES

Digitaria filiformis
Panicum verrucosum
“ capillare
“ philadelphicum
“ dichotomiflorum
Echinochloa Walteri
“ muricata
Cenchrus carolinianus
Zizania palustris
Aristida dichotoma

Aristida gracilis
“ tuberculosa
Sporobolus vaginiflorus
“ neglectus
Agrostis hyemalis
Leptochloa fascicularis
Eragrostis hypnoides
“ capillaris
“ Frankii
“ pilosa
Festuca octoflora

Naturalized species:

Anthoxanthum odoratum, Phleum pratense, Holcus lanatus, Arrhenatherum elatius, Dactylis glomerata, Festuca elatior, Agropyron caninum, hemicryptophyte semi-rosette plants without running branches; Poa compressa, P. trivialis, hemicryptophyte semi-rosette plants with running branches; Agropyron repens, Poa pratensis, rhizome geophytes; Digitaria humifusa, D. sanguinalis, Echinochloa crusgalli, Setaria glauca, S. verticillata, S. viridis, Eleusine indica, Eragrostis megastachya, Poa annua, Bromus tectorum (T or bien), therophytes.

CYPERACEAE

A family of grass-like or rush-like herbs represented by twelve genera, one hundred eighty-three species grouped as follows:

HEMICRYPTOPHYTES

Hemicryptophyte semi-rosette plants without running branches

Scirpus planifolius
Eriophorum callitrix
Rynchospora macrostachya
“ alba
Scleria verticillata
Carex scoparia
“ tribuloides
“ Crawfordii
“ cristata
“ abolutescens
“ mirabilis

Carex straminea
“ hormathodes
“ Bicknellii
“ silicea
“ alata
“ festucacea var. brevior
“ Bebbii
“ foenea
“ aenea
“ stellulata
“ sterilis

Carex scirpoides
“ seorsa
“ canescens
“ brunnescens
“ bromoides
“ Deweyana
“ trisperma
“ retroflexa
“ diandra
“ stipata
“ laevivaginata
“ crinita
“ aquatilis
“ torta
“ stricta
“ triceps var. hirsuta
“ virescens
“ aestivalis
“ Willdenowii
“ umbellata
“ nigro-marginata
“ communis
“ varia
“ Bushii
“ pallescens
“ paupercula var. pallens
“ prasina

Carex plantaginea
“ platyphylla
“ laxiculmis
“ digitalis
“ ptychocarpa
“ laxiflora
“ oligocarpa
“ grisea
“ glaucodea
“ Crawei
“ flava
“ Oederi var. pumila
“ castanea
“ arctata
“ debilis var. Rudgei
“ squarrosa
“ typhina
“ Pseudo-Cyperus
“ comosa
“ hystericina
“ lurida
“ Schweinitzii
“ retrorsa
“ intumescens
“ folliculata
“ subulata

WITH RUNNING BRANCHES

Cyperus dentatus
Eleocharis rostellata
Scirpus atrovirens
“ georgianus
“ polyphyllus
“ lineatus
“ Peckii
“ cyperinus
“ Eriophorum
“ pedicellatus
“ atrocinctus
“ Longii
Eriophorum virginicum

Rynchospora fusca
“ glomerata
Carex leptalea
“ polygama
“ novae-angliae
“ limosa
“ pedunculata
“ granularis
“ scabrata
“ lupuliformis
“ lupulina
“ Grayii

GEOPHYTES

RHIZOME GEOPHYTES

Eleocharis olivacea
“ acicularis
“ tenuis
Eriophorum gracile
“ tenellum
“ viridi-carinatum
Scleria triglomerata
“ pauciflora
Carex siccata
“ tenella
“ rosea
“ Muhlenbergii
“ cephalophora
“ sparganioides
“ cephaloidea

Carex alopoecoidea
“ vulpinoidea
“ setacea var. ambigua
“ aurea
“ pauciflora
“ formosa
“ Davisii
“ gracillima
“ pennsylvanica
“ pubescens
“ livida
“ panicea
“ tetanica
“ polymorpha
“ littoralis

Carex eburnea
" Hitchcockiana
" conoidea
" longirostris
" filiformis
" lanuginosa
" vestita
Carex oligosperma
" trichocarpa
" riparia
" vesicaria
" bullata
" Tuckermani

Stem tuber geophytes

Cyperus esculentus
" strigosus
Cyperus Grayii
" filiculmis

HELOPHYTES

Dulichium arundinaceum
Eleocharis quadrangulata
" palustris
Scirpus hudsonianus
" subterminalis
" americanus
" Torreyi
" Olneyi
Scirpus validus
" fluviatilis
" robustus
" campestris
" rubrotinctus
" sylvaticus
Cladium mariscoides
Carex rostrata

HYDROPHYTES

Eleocharis Robbinsii

THEROPHYTES

Cyperus diandrus
" rivularis
" Nuttallii
" aristatus
" erythrorhizos
" ferax
Eleocharis diandra
" ovata
" obtusa
" Engelmanni
Eleocharis tuberculosa
" Torreyana
" intermedia
Stenophyllus capillaris
Fimbristylis Frankii
Scirpus nanus
" debilis
" Smithii
Hemicarpha micrantha

Araceae

A family of herbs represented by six genera, seven species: Symplocarpus foetidus, rhizome geophyte; Arisaema triphyllum, A. Dracontium, stem tuber geophytes; Peltandra virginica, Calla palustris, Orontium aquaticum, Acorus Calamus, helophytes.

Lemnaceae

A family of minute free-floating plants represented by three genera, five species: Spirodela polyrhiza, Lemna trisulca, L. valdiviana, L. minor, Wolffia columbiana, hydrophytes.

Eriocaulaceae

A family of aquatic or marsh herbs represented by one genus two species: Eriocaulon septangulare, E. Parkeri, hydrophytes.

XYRIDACEAE

A family of herbs represented by one genus, four species: Xyris caroliniana, X. flexuosa, hemicryptophyte rosette plants without running branches; Xyris montana, X. Smalliana, hemicryptophyte rosette plants with running branches.

COMMELINACEAE

A family of herbs represented by one genus, one species: Tradescantia virginiana, protohemicryptophyte without running branches.

NATURALIZED SPECIES:

Commelina communis, protohemicryptophyte without running branches.

PONTEDERIACEAE

A family of aquatic herbs represented by two genera, three species: Pontederia cordata, helophyte; Heteranthera reniformis, H. dubia, hydrophytes.

JUNCACEAE

A family of grass-like or rush-like species represented by two genera, twenty species grouped as follows:

HEMICRYPTOPHYTES

HEMICRYPTOPHYTE SEMI-ROSETTE PLANTS

WITHOUT RUNNING BRANCHES

Juncus tenuis
" secundus
" Dudleyi
" dichotomus
" Greenei
" effusus

WITH RUNNING BRANCHES

Luzula saltuensis

Juncus brachycephalus
" brevicaudatus
" acuminatus
" debilis
" marginatus
Luzula campestris var. multiflora

GEOPHYTES

RHIZOME GEOPHYTES

Juncus Gerardi
" canadensis
" pelocarpus
Juncus nodosus
" articulatus

HELOPHYTES

Juncus militaris

THEROPHYTES

Juncus bufonius

LILIACEAE

A family of herbs and rarely woody plants represented by seventeen genera, thirty-one species grouped as follows:

PHANEROPHYTES

MICROPHANEROPHYTES

Smilax rotundifolia (vine)
“ glauca (vine)
Smilax hispida (vine)

HEMICRYPTOPHYTES

PROTOHEMICRYPTOPHYTES

WITH RUNNING BRANCHES
Smilax herbacea
Maianthemum canadense

GEOPHYTES

RHIZOME GEOPHYTES

Chamaelirium luteum
Melanthium latifolium
Veratrum viride
Uvularia perfoliata
“ grandiflora
Oakesia sessilifolia
Clintonia borealis
Smilacina racemosa
“ stellata
“ trifolia
Streptopus amplexifolius
“ roseus
Polygonatum biflorum
“ commutatum
Medeola virginiana
Trillium erectum
“ grandiflorum
“ cernuum
“ undulatum
Aletris farinosa

BULB GEOPHYTES

Allium tricoccum
“ canadense
Lilium philadelphicum
Lilium superbum
“ canadense
Erythronium americanum

NATURALIZED SPECIES:

Ornithogalum umbellatum, Muscari racemosum, Allium vineale, bulb geophytes; Asparagus officinalis, rhizome geophyte; Hemerocallis fulva, root tuber geophyte.

HAEMODORACEAE

A family of herbs represented by one genus, one species: Lachnanthes tinctoria, hemicryptophyte semi-rosette plant with running branches.

DIOSCOREACEAE

A family of herbs represented by one genus, one species: Dioscorea villosa, rhizome geophyte.

AMARYLLIDACEAE

A family of herbs represented by one genus, one species: Hypoxis hirsuta, bulb geophyte.

Iridaceae

A family of herbs represented by two genera, six species: Sisyrinchium mucronatum, S. angustifolium, S. gramineum, S. atlanticum, hemicryptophyte semi-rosette plants with running branches; Iris versicolor, I. prismatica, rhizome geophytes.

Orchidaceae

A family of herbs represented by twelve genera, forty species grouped as follows:

HEMICRYPTOPHYTES

Hemicryptophyte semi-rosette plants without running branches

Spiranthes vernalis
“ lucida
Spiranthes cernua
“ Romanzoffiana[1]

Hemicryptophyte rosette plants without running branches

Spiranthes Beckii
“ gracilis
Liparis liliifolia
“ Loeselii

with running branches

Epipactis repens
“ tesselata
Epipactis pubescens

GEOPHYTES

Rhizome geophytes

Cypripedium parviflorum
“ hirsutum
“ acaule
Corallorrhiza trifida
“ maculata
“ odontorhiza

Stem tuber geophytes

Calopogon pulchellus
Arethusa bulbosa
Microstylis monophyllos
Microstylis unifolia
Aplectrum hyemale

Root tuber geophytes

Orchis spectabilis
Habenaria bracteata
“ flava
“ hyperborea
“ dilatata
“ clavellata
“ Hookeri
“ orbiculata
“ macrophylla
Habenaria ciliaris
“ blephariglottis
“ lacera
“ psycodes
“ fimbriata
Pogonia ophioglossoides
“ trianthophora
“ verticillata
“ affinis

Piperaceae

A family of marsh herbs represented by one genus, one species: Saururus cernuus, helophyte.

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[1] Geophyte according to Taylor.

SALICACEAE

A family of trees and shrubs represented by two genera, eighteen species grouped as follows:

PHANEROPHYTES

MESOPHANEROPHYTES

Salix nigra (Mg)
Populus tremuloides
" grandidentata
Populus heterophylla
" balsamifera
" deltoides (Mg)

MICROPHANEROPHYTES

Salix lucida
" serissima
" longifolia
" cordata
Salix discolor
" sericea
" subsericea
" rostrata

NANOPHANEROPHYTES

Salix pedicellaris
" humilis
Salix tristis
" candida

NATURALIZED SPECIES:

Salix fragilis, S. alba, Populus alba, P. candicans, mesophanerophytes.

MYRICACEAE

A family of shrubs represented by one genus, three species: Myrica carolinensis, microphanerophyte; Myrica Gale, M. asplenifolia, nanophanerophytes.

JUGLANDACEAE

A family of trees represented by two genera, seven species: Juglans nigra (Ms), Carya ovata (Ms), megaphanerophytes; Juglans cinerea, Carya alba, C. microcarpa, C. glabra, C. cordiformis, mesophanerophytes.

BETULACEAE

A family of trees and shrubs represented by five genera, eleven species grouped as follows:

PHANEROPHYTES

MESOPHANEROPHYTES

Ostrya virginiana
Carpinus caroliniana
Betula lenta
Betula lutea
" populifolia
" alba var. papyrifera

MICROPHANEROPHYTES

Corylus americana
" rostrata (N)
Betula pumila
Alnus incana
" rugosa

Fagaceae

A family of trees and shrubs represented by three genera, fourteen species grouped as follows:

PHANEROPHYTES

Megaphanerophytes

Fagus grandifolia (Ms)
Castanea dentata
Quercus alba
“ macrocarpa
Quercus Muhlenbergii
“ rubra
“ palustris
“ velutina

Mesophanerophytes

Quercus stellata
“ bicolor (Mg)
Quercus Prinus
“ coccinea

Microphanerophytes

Quercus prinoides
Quercus ilicifolia

Urticaceae

A family of trees, shrubs and herbs represented by ten genera, eleven species grouped as follows:

PHANEROPHYTES

Megaphanerophytes

Ulmus americana

Mesophanerophytes

Ulmus fulva
Celtis occidentalis
Morus rubra

HEMICRYPTOPHYTES

Protohemicryptophytes with running branches

Urtica gracilis
Urtica Lyallii

GEOPHYTES

Rhizome geophytes

Humulus Lupulus
Laportea canadensis
Boehmeria cylindrica

THEROPHYTES

Pilea pumila
Parietaria pennsylvanica

Naturalized species:
Morus alba, mesophanerophyte; Cannabis sativa, therophyte.

Santalaceae

A family of herbs, shrubs and a few trees represented by one genus, one species; Comandra umbellata, rhizome geophyte.

Loranthaceae

A family chiefly of shrubby plants parasitic on trees, represented by one genus, one species: Arceuthobium pusillum, epiphytic phanerophyte.

Aristolochiaceae

A family of twining shrubs or low herbs represented by two genera, two species: Asarum canadense, hemicryptophyte rosette plant with running branches; Aristolochia Serpentaria, rhizome geophyte.

Polygonaceae

A family of herbs, twining vines, shrubs and trees represented by three genera, twenty-three species grouped as follows:

HEMICRYPTOPHYTES

Protohemicryptophytes

with running branches

Polygonum amphibium

without running branches

Polygonum aviculare (T)
“ Muhlenbergii
“ acre (T)
“ hydropiperoides
Polygonum arifolium (T)
“ cilinode
“ scandens
“ dumetorum

Hemicryptophyte semi-rosette plants

without running branches

Rumex Britannica
Rumex verticillatus

GEOPHYTES

Rhizome geophyte

Polygonum virginianum

THEROPHYTES

Polygonum exsertum
“ prolificum
“ erectum
“ ramosissimum var. atlanticum
“ tenue
“ pennsylvanicum
Polygonum Careyi
“ acre var. leptostachyum
“ sagittatum
“ Hydropiper
Polygonella articulata

Naturalized species:

Rumex crispus, R. obtusifolius, hemicryptophyte semi-rosette plants without running branches; Rumex Acetosella, hemicryptophyte semi-rosette plant with running branches; Polygonum lapathifolium, P. Persicaria, P. Convolvulus, therophytes.

Chenopodiaceae

A family of herbaceous weedy plants represented by five genera, twelve species: Salicornia ambigua, rhizome geophyte; the other species, listed below, therophytes:

Chenopodium rubrum
“ hybridum
“ Boscianum
“ leptophyllum
Atriplex patula
“ arenaria
Salicornia mucronata
“ europaea
Suaeda maritima
“ linearis
Salsola Kali

Naturalized species:

Chenopodium ambrosioides, C. Botrys, C. album, therophytes.

Amaranthaceae

A family of weedy herbs represented by one genus, one species: Acnida cannabina, therophyte.

Naturalized species:

Amaranthus retroflexus, A. hybridus, A. gracecizans, therophytes.

Phytolaccaceae

A family of herbs represented by one genus, one species: Phytolacca decandra, root tuber geophyte.

Illecebraceae

A family of small herbs represented by one genus, one species: Anychia canadensis, therophyte.

Naturalized species:

Scleranthus annuus, therophyte.

Aizoaceae

A family of herbs represented by no native species.

Naturalized species:

Mollugo verticillata, therophyte.

Caryophyllaceae

A family of herbs represented by ten genera, seventeen species grouped as follows:

CHAMAEPHYTES

Passive chamaephytes

Arenaria stricta
" groenlandica
Cerastium arvense

HEMICRYPTOPHYTES

Protohemicryptophytes
with running branches

Arenaria lateriflora
Arenaria macrophylla

Hemicryptophyte semi-rosette plants
without running branches

Silene pennsylvanica G?)
Silene stellata (G?)

with running branches

Sagina procumbens (T)

GEOPHYTES

Rhizome geophytes

Arenaria peploides[1]

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[1] Succulent according to Taylor.

THEROPHYTES

Spergularia rubra
“ marina[1]
“ canadensis
Sagina decumbens
Stellaria borealis
“ longifolia
Cerastium nutans
Silene antirrhina

NATURALIZED SPECIES:

Stellaria Holostea, passive chamaephyte; Cerastium vulgatum, active chamaephyte; Silene latifolia, Stellaria graminea, Saponaria officinalis, protohemicryptophytes with running branches; Lychnis Flos-cuculi, L. alba (bien), hemicryptophyte semi-rosette plants without running branches; Spergula arvensis, Arenaria serpyllifolia, Stellaria media, Cerastium semidecandrum, Dianthus Armeria, therophytes

PORTULACACEAE

A family of herbs represented by one genus, two species: Claytonia virginica, C. caroliniana, stem tuber geophytes.

NATURALIZED SPECIES:

Portulaca oleracea, therophyte.

CERATOPHYLLACEAE

A family of aquatic herbs represented by one genus, one species: Ceratophyllum demersum, submerged hydrophyte.

NYMPHAEACEAE

A family of aquatic herbs represented by four genera, six species: Nymphaea advena, N. microphylla, Castalia odorata, C. tuberosa, Nelumbo lutea, Brasenia Schreberi, hydrophytes with horizontal rootstocks and floating leaves.

RANUNCULACEAE

A family of herbs and woody plants represented by thirteen genera, thirty-eight species grouped as follows:

PHANEROPHYTES

NANOPHANEROPHYTES

Clematis virginiana (vine)
Clematis verticillaris (vine)

HEMICRYPTOPHYTES

HEMICRYPTOPHYTE SEMI-ROSETTE PLANTS WITHOUT RUNNING BRANCHES

Ranunculus micranthus
“ abortivus (bien)
“ allegheniensis (bien)
“ recurvatus
“ fascicularis
“ hispidus
Thalictrum dioicum
“ revolutum
“ dasycarpum
Thalictrum polygamum
Anemone cylindrica
“ riparia
“ virginiana
“ canadensis
Caltha palustris
Trollius laxus
Aquilegia canadensis

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[1] Succulent according to Taylor.

With running branches

Ranunculus Cymbalaria
“ laxicaulis
“ Flammula var. reptans
Ranunculus septentrionalis
“ repens

Hemicryptophyte rosette plants

without running branches

Hepatica triloba
Hepatica acutiloba

with running branches

Coptis trifolia

GEOPHYTES

Rhizome geophytes

Anemone quinquefolia
Cimicifuga racemosa
Actaea rubra
Actaea alba
Hydrastis canadensis

Root tuber geophytes

Anemonella thalictroides

HYDROPHYTES

Ranunculus circinatus
“ aquatilis var. capillaceus
Ranunculus delphinifolius

THEROPHYTES

Ranunculus sceleratus
Ranunculus pennsylvanicus

Naturalized species:

Ranunculus bulbosus, R. acris, hemicryptophyte semi-rosette plants without running branches.

Magnoliaceae

A family of trees and shrubs represented by one genus, one species: Liriodendron Tulipifera, megaphanerophyte.

Menispermaceae

A family of vines represented by one genus, one species: Menispermum canadense, semi-shrubby chamaephyte.

Berberidaceae

A family of shrubs and herbs represented by two genera, two species: Podophyllum peltatum, Caulophyllum thalictroides, rhizome geophytes.

Naturalized species:

Berberis vulgaris, microphanerophyte.

Lauraceae

A family of aromatic trees and shrubs represented by two genera, two species: Sassafras variifolium, mesophanerophyte; Benzoin aestivale, microphanerophyte.

Papaveraceae

A family of herbs represented by one genus, one species: Sanguinaria canadensis, rhizome geophyte.

Naturalized species:

Chelidonium majus (bien), hemicryptophyte semi-rosette plant without running branches.

Fumariaceae

A family of herbs represented by three genera, four species: Adlumia fungosa (vine), Corydalis sempervirens (bien), hemicryptophyte semi-rosette plants without running branches; Dicentra Cucullaria, D. canadensis, bulb geophytes.

Cruciferae

A family of herbs represented by nine genera, twenty-three species grouped as follows:

HEMICRYPTOPHYTES

Hemicryptophyte semi-rosette plants without running branches

Erysimum cheiranthoides (bien or T)
Radicula palustris (bien or T)
Barbarea stricta (bien)
Cardamine pratensis
" parviflora (bien or T)
" pennsylvanica (bien or T)
Arabis lyrata (bien or per)
Arabis viridis (bien or per)
" glabra (bien)
" hirsuta (bien)
" laevigata (bien)
" canadensis (bien)
" Drummondi (bien)

GEOPHYTES

Rhizome geophytes

Dentaria diphylla
" maxima
Dentaria incisifolia

Stem tuber geophytes

Dentaria laciniata
" anomala
Cardamine bulbosa
" Douglassii

THEROPHYTES

Draba caroliniana
Lepidium virginicum
Cakile edentula

Naturalized species:

Draba verna (bien or T), Lepidium apetalum (bien or T), Raphanus Raphanistrum (bien or T), Radicula sylvestris, Barbarea vulgaris, Diplotaxis tenuifolia, hemicryptophyte semi-rosette plants without running branches; Radicula Armoracia, root tuber geophyte; Radicula Nasturtium-aquaticum, hydrophyte; Capsella Bursa-pastoris, Brassica arvensis, B. juncea, B. nigra, Sisymbrium officinale var. leiocarpum, S. Thalianum, therophytes.

Capparidaceae

A family of herbs and shrubs represented by one genus, one species: Polanisia graveolens, therophyte.

SARRACENIACEAE

A family of bog plants represented by one genus, one species: Sarracenia purpurea, hemicryptophyte rosette plant without running branches.

DROSERACEAE

A family of bog herbs represented by one genus, two species: Drosera rotundifolia, D. longifolia, hemicryptophyte rosette plants without running branches.

PODOSTEMACEAE

A family of aquatic herbs represented by one genus, one species: Podostemum ceratophyllum, hydrophyte.

CRASSULACEAE

A family of herbs represented by two genera, two species: Penthorum sedoides, protohemicryptophyte with running branches Tillaea aquatica, therophyte.

NATURALIZED SPECIES:

Sedum acre, passive chamaephyte; Sedum triphyllum, protohemicryptophyte without running branches.

SAXIFRAGACEAE

A family of herbs and shrubs represented by seven genera, fifteen species grouped as follows:

PHANEROPHYTES

NANOPHANEROPHYTES

Ribes Cynosbati
" rotundifolium
" oxyacanthoides
Ribes americanum
" lacustre
" prostratum

HEMICRYPTOPHYTES

PROTOHEMICRYPTOPHYTES
WITH RUNNING BRANCHES

Chrysosplenium americanum

HEMICRYPTOPHYTE SEMI-ROSETTE PLANTS
WITHOUT RUNNING BRANCHES

Parnassia caroliniana

WITH RUNNING BRANCHES

Mitella prostrata
" diphylla
Mitella nuda

HEMICRYPTOPHYTE ROSETTE PLANTS
WITH RUNNING BRANCHES

Saxifraga pennsylvanica
" virginiensis
Tiarella cordifolia
Heuchera americana

NATURALIZED SPECIES:

Ribes vulgare, nanophanerophyte.

HAMAMELIDACEAE

A family of trees and shrubs represented by two genera, two species: Liquidambar Styraciflua, megaphanerophyte; Hamamelis virginiana, microphanerophyte.

PLATANACEAE

A family of trees represented by one genus, one species: Platanus occidentalis, megaphanerophyte.

ROSACEAE

A family of herbs, shrubs and trees represented by sixteen genera, eighty-seven species grouped as follows:

PHANEROPHYTES

MESOPHANEROPHYTES

Pyrus americana
Amelanchier canadensis
Prunus serotina (Mg)
Prunus pennsylvanica
“ americana

MICROPHANEROPHYTES

Physocarpus opulifolius
Pyrus arbutifolia (N)
Amelanchier oblongifolia
“ sanguinea
Crataegus Crus-galli
“ punctata
“ foetida
“ apposita
“ coccinea
“ Stonei
“ rotundifolia
“ roanensis
“ macrosperma
“ Grayana
Crataegus Napaea
“ pruinosa
“ deltoides
“ Jesupi
“ Holmesiana
“ Pringlei
“ pedicellata
“ polita
“ Arnoldiana
“ Brainerdi
“ macracantha
Prunus virginiana
“ alleghaniensis
“ nigra (Ms)

NANOPHANEROPHYTES

Spiraea latifolia
“ tomentosa
Pyrus melanocarpa
Amelanchier stolonifera
Potentilla fruticosa
Rosa blanda
“ nitida
Rosa carolina
“ virginiana
“ humilis
Prunus maritima
“ Gravesii
“ cuneata

CHAMAEPHYTES

SEMI-SHRUBBY CHAMAEPHYTES

Potentilla tridentata

HEMICRYPTOPHYTES

PROTOHEMICRYPTOPHYTES WITH RUNNING BRANCHES

Rubus idaeus var. aculeatissimus
“ neglectus
“ occidentalis
“ odoratus
“ triflorus
“ allegheniensis
Rubus frondosus
“ pergratus
“ recurvans
“ Randii
“ canadensis
“ cuneifolius

Rubus Andrewsianus
“ floricomus
“ setosus
“ nigricans
“ hispidus
“ villosus

Agrimonia gryposepala
“ striata
“ mollis
“ parviflora
“ rostellata

HEMICRYPTOPHYTE SEMI-ROSETTE PLANTS

WITHOUT RUNNING BRANCHES

Potentilla arguta
“ monspeliensis (bien or T)
Geum canadense
“ flavum

Geum virginianum
“ strictum
“ rivale
Sanguisorba canadensis

WITH RUNNING BRANCHES

Potentilla argentea
“ pacifica

Potentilla pumila
“ canadensis

HEMICRYPTOPHYTE ROSETTE PLANTS

WITH RUNNING BRANCHES

Fragaria virginiana[1]
“ vesca var. americana[1]

Waldsteinia fragarioides
Dalibarda repens

HELOPHYTES

Potentilla palustris

NATURALIZED SPECIES:

Prunus avium, mesophanerophyte; Prunus Mahaleb, microphanerophyte; Rosa cinnamomea, R. rubiginosa, nanophanerophytes; Filipendula rubra, protohemicryptophyte without running branches.

LEGUMINOSAE

A family of herbs, shrubs and trees represented by thirteen genera, thirty-eight species grouped as follows:

CHAMEPHYTES

PASSIVE CHAMAEPHYTES

Phaseolus polystachyus

HEMICRYPTOPHYTES

PROTOHEMICRYPTOPHYTES

WITHOUT RUNNING BRANCHES

Cassia marilandica
Baptisia tinctoria
Tephrosia virginiana
Desmodium nudiflorum
“ grandiflorum
“ rotundifolium
“ glabellum
“ canescens
“ bracteosum
“ Dillenii
“ paniculatum
“ canadense
“ sessilifolium
“ rigidum

Desmodium obtusum
“ marilandicum
Lespedeza procumbens
“ repens
“ violacea
“ Nuttallii
“ Stuvei
“ virginica
“ frutescens
“ simulata
“ hirta
“ capitata
Lathyrus palustris
var. linearifolius

WITH RUNNING BRANCHES

Amphicarpa monoica

Amphicarpa Pitcheri

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[1] Chamaephyte according to Taylor.

HEMICRYPTOPHYTE SEMI-ROSETTE PLANTS
WITHOUT RUNNING BRANCHES

Lupinus perennis

GEOPHYTES

STEM TUBER GEOPHYTE

Apios tuberosa

RHIZOME GEOPHYTE

Lathyrus maritimus

THEROPHYTES

Cassia Chamaecrista
" nictitans
Crotalaria sagittalis
Strophostyles helvola

NATURALIZED SPECIES:

Gleditsia triacanthos, megaphanerophyte; Robinia Pseudo-Acacia, R. viscosa, mesophanerophytes; Coronilla varia, Vicia Cracca, protohemicryptophytes without running branches; Melilotus officinalis (bien), M. alba (bien), hemicryptophyte semi-rosette plants without running branches; Trifolium pratense, T. hybridum, hemicryptophyte rosette plants without running branches; Trifolium repens, hemicryptophyte rosette plant with running branches; Trifolium arvense, T. agrarium, T. procumbens, Medicago lupulina, Vicia angustifolia, V. tetrasperma, therophytes.

LINACEAE

A family of herbs (rarely shrubs) represented by one genus, five species: Linum striatum, L. virginianum, L. medium, L. floridanum var. intercursum, hemicryptophyte semi-rosette plants without running branches; Linum sulcatum, therophyte.

OXALIDACEAE

A family of herbs (rarely shrubs) represented by one genus, five species: Oxalis Acetosella, hemicryptophyte rosette plant with running branches; Oxalis violacea, bulb geophyte; Oxalis corniculata, rhizome geophyte; Oxalis stricta, O. filipes, therophytes.

GERANIACEAE

A family of herbs represented by one genus, four species: Geranium maculatum, hemicryptophyte semi-rosette plant with running branches; Geranium Robertianum (bien or T), hemicryptophyte semi-rosette plant without running branches; Geranium carolinianum, G. Bicknellii, therophytes.

RUTACEAE

A family of herbs, shrubs or trees represented by one genus, one species: Zanthoxylum americanum, microphanerophyte.

SIMARUBACEAE

A family of trees and shrubs represented by no native species.

NATURALIZED SPECIES:

Ailanthus glandulosa, mesophanerophyte.

POLYGALACEAE

A family of herbs, shrubs or small trees represented by one genus, seven species: Polygala polygama (bien), protohemicryptophyte without running branches; Polygala paucifolia, protohemicryptophyte with running branches; Polygala Senega, rhizome geophyte; Polygala sanguinea, P. Nuttallii, P. cruciata, P. verticillata, therophytes.

EUPHORBIACEAE

A family of herbs (rarely shrubs or small trees) represented by three genera, seven species: Crotonopsis linearis, Acalypha virginica, A. gracilens, Euphorbia polygonifolia, E. Preslii, E. hirsuta, E. maculata, therophytes.

NATURALIZED SPECIES:

Euphorbia Cyparissias, protohemicryptophyte with running branches.

CALLITRICHACEAE

A family of herbaceous aquatic plants represented by one genus, three species: Callitriche palustris, C. heterophylla, hydrophytes; Callitriche deflexa var. Austini, therophyte.

LIMNANTHACEAE

A family of low, tender annuals represented by one genus, one species: Floerkea proserpinacoides, therophyte.

ANACARDIACEAE

A family of trees or shrubs represented by one genus, six species: Rhus Toxicodendron (vine), mesophanerophyte; Rhus typhina, R. glabra, R. copallina, R. Vernix, microphanerophytes; Rhus canadensis, nanophanerophyte.

AQUIFOLIACEAE

A family of trees and shrubs represented by two genera, six species: *Ilex opaca*, I. monticola var. mollis, mesophanerophytes; Ilex verticillata, I. laevigata, Nemopanthus mucronata, microphanerophytes; *Ilex glabra*, nanophanerophyte.

CELASTRACEAE

A family of shrubs represented by one genus, one species: Celastrus scandens (vine), microphanerophyte.

STAPHYLEACEAE

A family of trees represented by one genus, one species: Staphylea trifolia, microphanerophyte.

Aceraceae

A family of trees and shrubs represented by one genus, six species: Acer saccharinum, A. saccharum, A. rubrum, megaphanerophytes; Acer pennsylvanicum, A. Negundo, mesophanerophytes A. spicatum (Ms.), microphanerophyte.

Balsaminaceae

A family of herbs or undershrubs represented by one genus, two species: Impatiens pallida, I. biflora, therophytes.

Rhamnaceae

A family of shrubs and small trees represented by two genera, two species: Rhamnus alnifolia, Ceanothus americanus, nanophanerophytes.

Naturalized species:

Rhamnus cathartica, microphanerophyte.

Vitaceae

A family of climbing or erect shrubs represented by two genera, six species: Psedera quinquefolia, P. vitacea, Vitis labrusca, V. aestivalis, V. bicolor, V. vulpina, mesophanerophytes (vines).

Tiliaceae

A family of trees (rarely herbs) represented by one genus, two species: Tilia americana, megaphanerophyte; Tilia Michauxii, mesophanerophyte.

Malvaceae

A family of herbs, shrubs and sometimes trees represented by one genus, one species: Hibiscus Moscheutos, protohemicryptophyte without running branches.

Naturalized species:

Hibiscus syriacus, microphanerophyte, Malva rotundifolia, hemicryptophyte rosette plant without running branches; Althaea officinalis, root geophyte; Abutilon Theophrasti, therophyte.

Hypericaceae

A family of herbs, shrubs and sometimes small trees represented by one genus, eleven species grouped as follows:

HEMICRYPTOPHYTES

Protohemicryptophytes
without running branches

Hypericum mutilum (T)
" majus (T)
Hypericum canadense (T)

WITH RUNNING BRANCHES

Hypericum Ascyron
" punctatum[1]
" adpressum[2]
" Bissellii[1]
Hypericum ellipticum[1]
" boreale
" virginicum[1]

THEROPHYTES

Hypericum gentianoides

NATURALIZED SPECIES:

Hypericum perforatum,[1] protohemicryptophyte without running branches.

ELATINACEAE

A family of marsh annuals represented by one genus, one species: Elatine americana, therophyte.

CISTACEAE

A family of low shrubs or herbs represented by three genera, ten species grouped as follows:

CHAMAEPHYTES

PASSIVE CHAMAEPHYTES

Hudsonia tomentosa
Hudsonia ericoides

HEMICRYPTOPHYTES

PROTOHEMICRYPTOPHYTES
WITHOUT RUNNING BRANCHES

Helianthemum canadense
" majus
Lechea villosa
" minor
Lechea intermedia
" maritima
" tenuifolia
" Leggettii

VIOLACEAE

A family of herbs or shrubs represented by one genus, twenty-seven species, grouped as follows:

HEMICRYPTOPHYTES

HEMICRYPTOPHYTE SEMI-ROSETTE PLANTS
WITH RUNNING BRANCHES

Viola pubescens
" scabriuscula
" canadensis
Viola conspersa
" rostrata

HEMICRYPTOPHYTE ROSETTE PLANTS
WITH RUNNING BRANCHES

Viola pedata
" cucullata
" nephrophylla[1]
" affinis
" latiuscula
" papilionacea
Viola palmata
" triloba
" sororia
" septentrionalis
" fimbriatula
" sagittata

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[1] Geophyte according to Taylor.
[2] Chamaephyte according to Taylor.

Viola emarginata
“ Brittoniana
“ pectinata
“ Selkirkii
“ lanceolata

Viola primulifolia
“ pallens
“ blanda
“ incognita
“ rotundifolia

Cactaceae

A family of fleshy plants represented by one genus, one species: Opuntia vulgaris, phanerophyte stem succulent (ch).

Thymelaeaceae

A family of shrubs and trees (rarely herbs) represented by one genus, one species: Dirca palustris, nanophanerophyte.

Lythraceae

A family of herbs, shrubs and trees represented by four genera, four species: Decodon verticillatus, semi-shrubby chamaephyte; Lythrum alatum, protohemicryptophyte with running branches: Rotala ramosior, Cuphea petiolata, therophytes.

Naturalized species:

Lythrum Salicaria, protohemicryptophyte with running branches.

Melastomaceae

A family of herbs, shrubs and trees represented by one genus, one species: Rhexia virginica, rhizome geophyte.

Onagraceae

A family of herbs represented by four genera, twenty-one species grouped as follows:

HEMICRYPTOPHYTES

Protohemicryptophytes

without running branches

Ludvigia alternifolia
Epilobium angustifolium

Epilobium coloratum[1]
“ adenocaulon[1]

with running branches

Ludvigia polycarpa
“ palustris
Epilobium molle

Epilobium densum
“ palustre

Hemicryptophyte semi-rosette plants

without running branches

Oenothera muricata (bien)
“ biennis (bien)
“ pumila
“ fruticosa

Oenothera linearis (bien or per)
“ longipedicellata
“ pratensis

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[1] See note p 18.

GEOPHYTES

Rhizome geophytes

Circaea lutetiana
Circaea alpina

HELOPHYTES

Ludvigia sphaerocarpa

THEROPHYTES

Oenothera cruciata
Oenothera Oakesiana

Haloragidaceae

A family of aquatic or marsh plants represented by two genera, seven species: Myriophyllum alterniflorum, M. spicatum, M. verticillatum var. pectinatum, M. scabratum, M. humile, M. tenellum, Proserpinaca palustris, hydrophytes.

Araliaceae

A family of herbs, shrubs and trees represented by two genera five species: Aralia hispida, semi-shrubby chamaephyte; Aralia racemosa, A. nudicaulis, protohemicryptophytes with running branches; Panax quinquefolium, P. trifolium, root tuber geophytes.

Umbelliferae

A family of herbs represented by fifteen genera, twenty-three species grouped as follows:

HEMICRYPTOPHYTES

Protohemicryptopyytes without running branches

Taenidia integerrima

Hemicryptophyte semi-rosette plants without running branches

Sanicula marilandica
“ gregaria
“ canadensis (bien)
“ trifoliata (bien)
Osmorhiza Claytoni
“ longistylis
Cicuta maculata
“ bulbifera
Sium cicutaefolium
Cryptotaenia canadensis
Zizia aurea
“ cordata
Ligusticum scothicum
Conioselinum chinense
Angelica villosa
“ atropurpurea

Hemicryptophyte rosette plants with running branches

Hydrocotyle umbellata
“ americana
Lilaeopsis lineata

GEOPHYTES

Rhizome geophytes

Eryngium yuccifolium

Root tuber geophyte

Heracleum lanatum

THEROPHYTES

Ptilimnium capillaceum

Naturalized species:

Conium maculatum (bien), Pastinaca sativa (bien), Daucus Carota (bien), hemicryptophyte semi-rosette plants without running branches.

Cornaceae

A family of trees and shrubs (rarely herbs) represented by two genera, eight species grouped as follows:

PHANEROPHYTES

Mesophanerophytes

Cornus florida

Nyssa sylvatica

Microphanerophytes

Cornus circinata
“ Amonum
“ paniculata

Cornus stolonifera
“ alternifolia (Ms)

HEMICRYPTOPHYTES

Protohemicryptophytes
with running branches

Cornus canadensis

Ericaceae

A family of trees, shrubs and perennial herbs represented by eighteen genera, thirty-nine species, grouped as follows:

PHANEROPHYTES

Microphanerophytes

Clethra alnifolia
Rhododendron viscosum
“ canescens
“ **maximum**
Kalmia latifolia

Leucothoë racemosa
Lyonia ligustrina
Vaccinium corymbosum
“ atrococcum

Nanophanerophytes

Ledum groenlandicum
Rhododendron nudiflorum
“ canadense
Kalmia angustifolia
“ **polifolia**
Andromeda glaucophylla (ch)
Lyonia mariana
Chamaedaphne calyculata

Gaylussacia dumosa
“ frondosa
“ baccata
Vaccinium stamineum
“ pennsylvanicum
“ canadense
“ vacillans

CHAMAEPHYTES

Passive chamaephytes

Vaccinium Oxycoccos

Vaccinium macrocarpon

Active chamaephytes

Epigaea repens
Arctostaphylos Uva-ursi

Chiogenes hispidula

HEMICRYPTOPHYTES

PROTOHEMICRYPTOPHYTES
WITH RUNNING BRANCHES

Chimaphila umbellata
“ maculata
Gaultheria procumbens

HEMICRYPTOPHYTE ROSETTE PLANTS
WITH RUNNING BRANCHES

Pyrola secunda
“ chlorantha
Pyrola elliptica
“ americana

GEOPHYTES

ROOT GEOPHYTES

Moneses uniflora
Monotropa uniflora
Monotropa Hypopitys

PLUMBAGINACEAE

A family of herbs represented by one genus, one species: Limonium carolinianum, hemicryptophyte semi-rosette plant without running branches.

PRIMULACEAE

A family of herbs represented by five genera, nine species, grouped as follows:

HEMICRYPTOPHYTES

PROTOHEMICRYPTOPHYTES
WITH RUNNING BRANCHES

NATURALIZED SPECIES:

Lysimachia quadrifolia
“ producta
“ terrestris
Steironema ciliatum
“ lanceolatum
Trientalis americana

HEMICRYPTOPHYTE SEMI-ROSETTE PLANTS
WITHOUT RUNNING BRANCHES

Samolus floribundus

HELOPHYTES

Lysimachia thyrsiflora

HYDROPHYTES

Hottonia inflata

NATURALIZED SPECIES:

Lysimachia Nummularia, active chamaephyte; Lysimachia punctata, protohemicryptophyte with running branches; Anagallis arvensis, therophyte.

EBENACEAE

A family of trees and shrubs represented by one genus, one species: Diospyros virginiana, mesophanerophyte.

Oleaceae

A family of trees and shrubs represented by one genus, three species: Fraxinus americana, megaphanerophyte; Fraxinus pennsylvanica, F. nigra, mesophanerophytes.

Naturalized species:
Syringa vulgaris, Ligustrum vulgare, microphanerophytes.

Gentianaceae

A family of herbs represented by five genera, nine species grouped as follows:

HEMICRYPTOPHYTES

Protohemicryptophytes

without running branches

Sabatia dodecandra (bien or per)
Gentiana crinita (bien or T)
" Andrewsii
Bartonia virginica (bien or T)
" paniculata (bien or T)

HELOPHYTES

Menyanthes trifoliata

HYDROPHYTES

Nymphoides lacunosum

THEROPHYTES

Sabatia stellaris
Gentiana quinquefolia

Apocynaceae

A family of herbs, shrubs, vines and some trees represented by one genus, three species: Apocynum androsaemifolium, A. medium, rhizome geophytes; Apocynum cannabinum, root geophyte.

Naturalized species:
Vinca minor, passive chamaephyte.

Asclepiadaceae

A family of herbs, vines or shrubs represented by two genera, ten species grouped as follows:

HEMICRYPTOPHYTES

Protohemicryptophytes

without running branches

Asclepias tuberosa
" incarnata
Asclepias verticillata

with running branches

Asclepias variegata
Asclepias quadrifolia

GEOPHYTES

Rhizome geophytes

Asclepias purpurascens
" syriaca
" amplexicaulis
Asclepias phytolaccoides
Acerates viridiflora

CONVOLVULACEAE

A family of twining or trailing herbs and some tropical shrubs and trees represented by three genera, eight species, grouped as follows:

GEOPHYTES

RHIZOME GEOPHYTES

Convolvulus spithamaeus
Convolvulus sepium

ROOT TUBER GEOPHYTES

Ipomoea pandurata

THEROPHYTES

Cuscuta obtusiflora
" arvensis
" Coryli
Cuscuta Gronovii
" compacta

POLEMONIACEAE

A family of herbs represented by one genus, one species: Polemonium Van-Bruntiae, hemicryptophyte semi-rosette plant with running branches.

HYDROPHYLLACEAE

A family of herbs represented by one genus, one species: Hydrophyllum virginianum, hemicryptophyte semi-rosette plant with running branches.

BORAGINACEAE

A family of herbs, shrubs and some tropical trees represented by four genera, seven species: Myosotis laxa, protohemicryptophyte without running branches; Cynoglossum virginianum, C. boreale, Lappula virginiana (bien), Myosotis arvensis (bien or T), M. virginica (bien or T), Onosmodium virginianum, hemicryptophyte semi-rosette plants without running branches.

NATURALIZED SPECIES:

Lithospermum officinale, protohemicryptophyte without running branches; Lithospermum arvense (bien or T), Echium vulgare (bien), hemicryptophyte semi-rosette plants; Symphytum officinale, root tuber geophyte.

VERBENACEAE

A family of herbs, shrubs and some tropical trees represented by one genus, three species: Verbena urticaefolia, V. angustifolia, V. hastata, protohemicryptophytes without running branches.

LABIATAE

A family of herbs, shrubs and a few tropical trees represented by fifteen genera, thirty-four species, grouped as follows:

HEMICRYPTOPHYTES

PROTOHEMICRYPTOPHYTES

WITHOUT RUNNING BRANCHES

Scutellaria integrifolia

WITH RUNNING BRANCHES

Teucrium canadense
Scutellaria lateriflora
" galericulata
Stachys hyssopifolia
" tenuifolia var. aspera
Monarda fistulosa
" mollis
Blephilia ciliata
" hirsuta
Satureja vulgaris
Pycnanthemum clinopodioides
" flexuosum
Pycnanthemum virginianum
" pilosum
" verticillatum
" incanum
muticum
Lycopus virginicus
" uniflorus
" sessilifolius
" rubellus
" americanus
Mentha arvensis

HEMICRYPTOPHYTE SEMI-ROSETTE PLANTS

WITHOUT RUNNING BRANCHES

Agastache nepetoides
" scrophulariaefolia
Prunella vulgaris
Salvia lyrata (bien or per)

GEOPHYTES

RHIZOME GEOPHYTES

Collinsonia canadensis

STEM TUBER GEOPHYTES

Scutellaria parvula
Stachys palustris

THEROPHYTES

Trichostema dichotomum
" lineare
Hedeoma pulegioides

NATURALIZED SPECIES:

Marrubium vulgare, Nepeta Cataria, Lamium amplexicaule (bien or T), Leonurus Cardiaca, protohemicryptophytes without running branches Nepeta hederacea, Monarda didyma, Mentha longifolia, M. spicata, M. piperita, M. gentilis, protohemicryptophytes with running branches; Galeopsis Tetrahit, therophyte.

SOLANACEAE

A family of herbs, shrubs, vines and some tropical trees represented by two genera, six species: Solanum carolinense, Physalis heterophylla, P. subglabrata, P. virginiana, rhizome geophytes; Solanum nigrum, Physalis pruinosa, therophytes.

NATURALIZED SPECIES:

Solanum Dulcamara (vine), nanophanerophyte, Datura Stramonium, D. Tatula, therophytes.

SCROPHULARIACEAE

A family of herbs, shrubs and trees represented by fifteen genera, thirty-four species grouped as follows:

CHAMAEPHYTES

PASSIVE CHAMAEPHYTES

Veronica Anagallis-aquatica
“ americana
Veronica officinalis

HEMICRYPTOPHYTES

PROTOHEMICRYPTOPHYTES

WITHOUT RUNNING BRANCHES

Scrophularia marilandica
“ leporella
Chelone glabra
Veronica serpyllifolia
Gerardia flava
“ virginica
Schwalbea americana

WITH RUNNING BRANCHES

Mimulus ringens
“ alatus
Gratiola aurea
Veronica virginica
“ scutellata

HEMICRYPTOPHYTE SEMI-ROSETTE PLANTS

WITHOUT RUNNING BRANCHES

Linaria canadensis (bien or T)
Pentstemon hirsutus
“ laevigatus var. Digitalis
Castilleja coccinea (bien or T)
Pedicularis canadensis
“ lanceolata

THEROPHYTES

Limosella aquatica var. tenuifolia
Ilysanthes dubia
“ anagallidea
Gratiola virginiana
Veronica peregrina
Gerardia pedicularia (bien or T)
“ purpurea
Gerardia paupercula
“ maritima
“ tenuifolia
“ parvifolia
Melampyrum lineare
Rhinanthus Crista-galli

NATURALIZED SPECIES:

Linaria vulgaris, protohemicryptophyte with running branches; Verbascum Thapsus (bien), V. Blattaria (bien), hemicryptophyte semi-rosette plants without running branches; Veronica arvensis, therophyte.

LENTIBULARIACEAE

A family of aquatic herbs represented by one genus, ten species, hydrophytes:

Utricularia inflata
“ clandestina
“ vulgaris var. americana
“ minor
“ gibba
Utricularia biflora
“ intermedia
“ purpurea
“ resupinata
“ cornuta

OROBANCHACEAE

A family of herbs (root-parasites) represented by three genera, three species: Epifagus virginiana, Conopholis americana, Orobanche uniflora, root geophytes.

PHRYMACEAE

A family of herbs represented by one genus, one species: Phryma Leptostachya, protohemicryptophyte with running branches.

PLANTAGINACEAE

A family of herbs represented by one genus, six species: Plantago major, P. Rugelii, P. decipiens, P. virginica (bien or T), hemicryptophyte rosette plants without running branches; Plantago aristata, P. elongata, therophytes.

NATURALIZED SPECIES:

Plantago lanceolata, hemicryptophyte rosette plant without running branches.

RUBIACEAE

A family of herbs, shrubs and trees represented by five genera, seventeen species grouped as follows:

PHANEROPHYTES

MICROPHANEROPHYTES

Cephalanthus occidentalis

CHAMAEPHYTES

Active chamaephytes

Mitchella repens

HEMICRYPTOPHYTES

PROTOHEMICRYPTOPHYTES

WITHOUT RUNNING BRANCHES

Galium pilosum
" circaezans
" lanceolatum
" palustre
" Claytoni
Galium tinctorium
" labradoricum
" asprellum
" triflorum

WITH RUNNING BRANCHES

Galium boreale
Galium trifidum

HEMICRYPTOPHYTE SEMI-ROSETTE PLANTS

WITHOUT RUNNING BRANCHES

Houstonia longifolia

WITH RUNNING BRANCHES

Houstonia caerulea

THEROPHYTES

Galium Aparine
Diodia teres

NATURALIZED SPECIES:

Galium Mollugo, protohemicryptophyte without running branches.

CAPRIFOLIACEAE

A family of trees, shrubs, vines and herbs represented by six genera, twenty species, grouped as follows:

PHANEROPHYTES

MESOPHANEROPHYTES

Lonicera sempervirens (vine)
Viburnum Lentago
Viburnum prunifolium

MICROPHANEROPHYTES

Lonicera dioica (vine)
Viburnum alnifolium
" Opulus var. americanum
" dentatum
Viburnum cassinoides
" nudum
Sambucus canadensis
" racemosa

Nanophanerophytes

Diervilla Lonicera
Lonicera caerulea var. villosa
“ canadensis
Viburnum acerifolium
“ pubescens

CHAMAEPHYTES

Active chamaephytes

Linnaea borealis var. **americana**

HEMICRYPTOPHYTES

Protohemicryptophytes
without running branches

Triosteum perfoliatum
“ aurantiacum
Triosteum angustifolium

Naturalized species:

Lonicera japonica, microphanerophyte

Valerianaceae

A family of herbs represented by one genus, one species: Valerianella radiata, therophyte.

Dipsacaceae

A family of herbs represented by no native species.

Naturalized species:

Dipsacus sylvestris (bien), hemicryptophyte semi-rosette plant without running branches.

Cucurbitaceae

A family of climbing or trailing herbaceous vines represented by two genera, two species: Sicyos angulatus, Echinocystis lobata, therophytes.

Campanulaceae

A family of herbs and some tropical shrubs and trees represented by two genera, four species: Campanula aparinoides, C. uliginosa, protohemicryptophytes with running branches; Campanula rotundifolia, hemicryptophyte semi-rosette plant with running branches: Specularia perfoliata, therophyte.

Naturalized species:

Campanula rapunculoides, hemicryptophyte semi-rosette plant without running branches.

Lobeliaceae

A family of herbs represented by one genus, six species: Lobelia cardinalis, L. siphilitica, L. spicata (bien or per), L. Kalmii, hemicryptophyte semi-rosette plants without running branches; Lobelia Dortmanna, hydrophyte; Lobelia inflata, therophyte.

Compositae

A family of herbs, shrubs and some tropical trees represented by thirty-three genera, one hundred fifty species grouped as follows:

PHANEROPHYTES

Microphanerophytes

Baccharis halimifolia

CHAMAEPHYTES

SEMI-SHRUBBY CHAMAEPHYTES

- Iva oraria (N)

PASSIVE CHAMAEPHYTES

- Antennaria Parlinii
- “ canadensis
- “ plantaginifolia
- “ fallax
- Antennaria occidentalis
- “ neodioica
- “ neglecta

HEMICRYPTOPHYTES

PROTOHEMICRYPTOPHYTES

WITHOUT RUNNING BRANCHES

- Vernonia noveboracensis
- Eupatorium hyssopifolium
- “ verbenaefolium
- “ pubescens
- “ sessilifolium
- “ urticaefolium
- “ aromaticum
- Polymnia canadensis
- Solidago speciosa
- Helenium autumnale
- Hieracium paniculatum
- “ scabrum
- “ canadense

WITH RUNNING BRANCHES

- Eupatorium purpureum
- “ perfoliatum
- Chrysopsis falcata
- Solidago caesia
- “ latifolia
- “ odora
- “ Elliottii
- “ rugosa
- “ asperula
- “ aspera
- “ altissima
- “ serotina
- “ graminifolia
- “ tenuifolia
- Aster radula
- “ novae-angliae
- “ patens
- “ concinnus
- “ amethystinus
- “ multiflorus
- “ dumosus
- “ paniculatus
- “ longifolius
- “ novi-belgii
- Aster tardiflorus
- “ prenanthoides
- “ puniceus
- “ umbellatus
- “ infirmus
- “ linariifolius
- “ tataricus
- “ acuminatus
- Anaphalis margaritacea
- Gnaphalium decurrens (bien or T)
- “ purpureum (bien or T)
- Heliopsis scabra
- Rudbeckia laciniata
- Helianthus grosseserratus
- “ giganteus
- “ divaricatus
- “ strumosus
- “ tracheliifolius
- “ decapetalus
- Bidens trichosperma (bien or T)
- Cacalia suaveolens

HEMICRYPTOPHYTE SEMI-ROSETTE PLANTS

WITHOUT RUNNING BRANCHES

- Sericocarpus asteroides
- “ linifolius
- Artemisia caudata (bien)
- Senecio aureus
- “ Balsamitae var. praelongus
- Cirsium spinosissimum(bien or per)
- “ discolor (bien or per)
- “ muticum (bien)
- “ pumilum (bien)
- Krigia amplexicaulis
- Lactuca canadensis (bien or T)
- Lactuca integrifolia (bien)
- “ hirsuta (bien or T)
- “ spicata (bien or T)
- Prenanthes alba
- “ serpentaria
- “ trifoliolata
- “ altissima
- Hieracium venosum
- “ marianum
- “ Gronovii

HEMICRYPTOPHYTE SEMI-ROSETTE PLANTS WITH RUNNING BRANCHES

Solidago squarrosa
“ bicolor
“ hispida
“ puberula
“ uliginosa
“ sempervirens
“ patula
“ arguta
“ juncea
“ neglecta
“ uniligulata
“ ulmifolia
“ nemoralis (ch)
“ canadensis
“ rigida
Aster divaricatus (ch)
“ Schreberi (ch)
Aster macrophyllus (ch)
“ Herveyi
“ spectabilis
“ undulatus
“ cordifolius
“ Lowrieanus
“ laevis (ch)
“ ericoides (ch)
“ vimineus
“ lateriflorus
“ Tradescanti
“ ptarmicoides
“ tenuifolius
Erigeron pulchellus
“ philadelphicus
Achillea Millefolium
Senecio obovatus

GEOPHYTES

RHIZOME GEOPHYTES

Mikania scandens
Petasites palmatus

STEM TUBER GEOPHYTES

Liatris scariosa

HYDROPHYTES

Bidens Beckii

THEROPHYTES

Aster subulatus
Erigeron annuus
“ ramosus
“ canadensis
“ pusillus
Pluchea camphorata
Gnaphalium polycephalum
“ uliginosum
Ambrosia trifida
“ artemisiifolia
Xanthium canadense
“ commune
Xanthium echinatum
Bidens discoidea
“ frondosa
“ vulgata
“ comosa
“ connata var. petiolata
“ cernua
“ laevis
“ bipinnata
Erechtites hieracifolia
Krigia virginica

NATURALIZED SPECIES:

Artemisia Stelleriana, semi-shrubby chamaephyte; Inula Helenium, Chrysanthemum Leucanthemum, Tanacetum vulgare, Arctium Lappa (bien), A. minus (bien), Cirsium lanceolatum (bien), Cichorium Intybus, Tragopogon pratensis (bien or per), Lactuca scariola var. integrata (bien or T.), hemicryptophyte semi-rosette plants without running branches; Sonchus arvensis, Hieracium aurantiacum, hemicryptophyte semi-rosette plants with running branches; Leontodon autumnalis, L. nudicaulis, Taraxacum officinale, T. erythrospermum, hemicryptophyte rosette plants without running branches; Tussilago Farfara, rhizome geophyte; Helianthus tuberosus, stem tuber geophyte; Cirsium arvense, root geophyte; Anthemis Cotula, Sonchus oleraceus, S. asper, therophytes.

III. A LIST OF THE SPECIES REPRESENTED IN THE CONNECTICUT FLORA ARRANGED BY FAMILIES AND GENERA AND TABULATED ACCORDING TO LIFE FORM.

The symbols used in this section are as follows:

Mg—megaphanerophytes
Ms—mesophanerophytes
M —microphanerophytes
N —nanophanerophytes
Ch —chamaephytes
H —hemicryptophytes
G —geophytes
HH—helophytes and hydrophytes
T —therophytes
S —succulents
E —epiphytes

	Mg	Ms	M	N	Ch	H	G	HH	T
Taxaceae	–	–	–	**1**	–	–	–	–	–
Taxus	–	–	–	1	–	–	–	–	–
Pinaceae	**4**	**7**	**1**	**1**	–	–	–	–	–
Pinus	2	1	–	–	–	–	–	–	–
Larix	–	1	–	–	–	–	–	–	–
Picea	1	1	–	–	–	–	–	–	–
Abies	–	1	–	–	–	–	–	–	–
Tsuga	1	–	–	–	–	–	–	–	–
Chamaecyparis	–	1	–	–	–	–	–	–	–
Thuja	–	1	–	–	–	–	–	–	–
Juniperus	–	1	1	1	–	–	–	–	–
Typhaceae	–	–	–	–	–	–	–	**2**	–
Typha	–	–	–	–	–	–	–	2	–
Sarganiaceae	–	–	–	–	–	–	–	**7**	–
Sparganium	–	–	–	–	–	–	–	7	–
Najadaceae	–	–	–	–	–	–	–	**33**	–
Potamogeton	–	–	–	–	–	–	–	28	–
Ruppia	–	–	–	–	–	–	–	1	–
Zannichellia	–	–	–	–	–	–	–	1	–
Zostera	–	–	–	–	–	–	–	1	–
Najas	–	–	–	–	–	–	–	2	–
Juncaginaceae	–	–	–	–	–	**2**	–	–	–
Scheuchzeria	–	–	–	–	–	1	–	–	–
Triglochin	–	–	–	–	–	1	–	–	–
Alismaceae	–	–	–	–	–	–	–	**9**	–
Sagittaria	–	–	–	–	–	–	–	7	–
Lophotocarpus	–	–	–	–	–	–	–	1	–
Alisma	–	–	–	–	–	–	–	1	–
Hydrocharitaceae	–	–	–	–	–	–	–	**2**	–
Elodea	–	–	–	–	–	–	–	1	–
Vallisneria	–	–	–	–	–	–	–	1	–
Gramineae	–	–	–	–	–	**122**(**9**)	**10**(2)	–	**21**(**10**)
Tripsacum	–	–	–	–	–	1	–	–	–
Andropogon	–	–	–	–	–	3	–	–	–
Sorghastrum	–	–	–	–	–	1	–	–	–
Digitaria	–	–	–	–	–	–	–	–	1(2)
Leptoloma	–	–	–	–	–	1	–	–	–
Paspalum	–	–	–	–	–	6	–	–	–
Panicum	–	–	–	–	–	35	2	–	4

Gramineae—cont.	Mg	Ms	M	N	Ch	H	G	HH	T
Echinochloa	–	–	–	–	–	–	–	–	2(1)
Setaria	–	–	–	–	–	–	1	–	(3)
Cenchrus	–	–	–	–	–	–	–	–	1
Zizania	–	–	–	–	–	–	–	–	1
Leersia	–	–	–	–	–	2	–	–	–
Phalaris	–	–	–	–	–	–	1	–	–
Anthoxanthum	–	–	–	–	–	(1)	–	–	–
Hierochloë	–	–	–	–	–	1	–	–	–
Milium	–	–	–	–	–	1	–	–	–
Oryzopsis	–	–	–	–	–	–	3	–	–
Stipa	–	–	–	–	–	1	–	–	–
Aristida	–	–	–	–	–	1	–	–	3
Muhlenbergia	–	–	–	–	–	8	–	–	–
Brachyelytrum	–	–	–	–	–	1	–	–	–
Phleum	–	–	–	–	–	(1)	–	–	–
Alopecurus	–	–	–	–	–	1	–	–	–
Sporobolus	–	–	–	–	–	5	–	–	2
Agrostis	–	–	–	–	–	2	–	–	1
Calamagrostis	–	–	–	–	–	2	–	–	–
Ammophila	–	–	–	–	–	–	1	–	–
Cinna	–	–	–	–	–	2	–	–	–
Holcus	–	–	–	–	–	(1)	–	–	–
Sphenopholis	–	–	–	–	–	4	–	–	–
Trisetum	–	–	–	–	–	1	–	–	–
Deschampsia	–	–	–	–	–	2	–	–	–
Arrhenatherum	–	–	–	–	–	(1)	–	–	–
Danthonia	–	–	–	–	–	2	–	–	–
Spartina	–	–	–	–	–	4	–	–	–
Bouteloua	–	–	–	–	–	1	–	–	–
Eleusine	–	–	–	–	–	–	–	–	(1)
Leptochloa	–	–	–	–	–	–	–	–	1
Phragmites	–	–	–	–	–	–	1	–	–
Tridens	–	–	–	–	–	1	–	–	–
Triplasis	–	–	–	–	–	1	–	–	–
Eragrostis	–	–	–	–	–	1	–	–	4(1)
Melica	–	–	–	–	–	1	–	–	–
Distichlis	–	–	–	–	–	–	1	–	–
Dactylis	–	–	–	–	–	(1)	–	–	–
Poa	–	–	–	–	–	3(2)	(1)	–	(1)
Glyceria	–	–	–	–	–	10	–	–	–
Puccinellia	–	–	–	–	–	2	–	–	–
Festuca	–	–	–	–	–	3(1)	–	–	1
Bromus	–	–	–	–	–	5	–	–	(1)
Agropyron	–	–	–	–	–	(1)	(1)	–	–
Hordeum	–	–	–	–	–	1	–	–	–
Elymus	–	–	–	–	–	5	–	–	–
Hystrix	–	–	–	–	–	1	–	–	–
Cyperaceae	–	–	–	–	–	**100**	**47**	**17**	**19**
Cyperus	–	–	–	–	–	1	4	–	6
Dulichium	–	–	–	–	–	–	–	1	–
Eleocharis	–	–	–	–	–	1	3	3	7
Stenophyllus	–	–	–	–	–	–	–	–	1
Fimbristylis	–	–	–	–	–	–	–	–	1
Scirpus	–	–	–	–	–	11	–	11	3
Eriophorum	–	–	–	–	–	2	3	–	–
Hemicarpha	–	–	–	–	–	–	–	–	1
Rynchospora	–	–	–	–	–	4	–	–	–
Cladium	–	–	–	–	–	–	–	1	–
Scleria	–	–	–	–	–	1	2	–	–
Carex	–	–	–	–	–	80	35	1	–

	Mg	Ms	M	N	Ch	H	G	HH	T
Araceae	–	–	–	–	–	–	3	4	–
Arisaema	–	–	–	–	–	–	2	–	–
Peltandra	–	–	–	–	–	–	–	1	–
Calla	–	–	–	–	–	–	–	1	–
Symplocarpus	–	–	–	–	–	–	1	–	–
Orontium	–	–	–	–	–	–	–	1	–
Acorus	–	–	–	–	–	–	–	1	–
Lemnaceae	–	–	–	–	–	–	–	5	–
Spirodela	–	–	–	–	–	–	–	1	–
Lemna	–	–	–	–	–	–	–	3	–
Wolffia	–	–	–	–	–	–	–	1	–
Eriocaulaceae	–	–	–	–	–	–	–	2	–
Eriocaulon	–	–	–	–	–	–	–	2	–
Xyridaceae	–	–	–	–	–	4	–	–	–
Xyris	–	–	–	–	–	4	–	–	–
Commelinacae	–	–	–	–	–	1(1)	–	–	–
Tradescantia	–	–	–	–	–	1	–	–	–
Commelina	–	–	–	–	–	(1)	–	–	–
Pontederiaceae	–	–	–	–	–	–	–	3	–
Pontederia	–	–	–	–	–	–	–	1	–
Heteranthera	–	–	–	–	–	–	–	2	–
Juncaceae	–	–	–	–	–	13	5	1	1
Juncus	–	–	–	–	–	11	5	1	1
Luzula	–	–	–	–	–	2	–	–	–
Liliaceae	–	–	3	–	–	2	26(5)	–	–
Chamaelirium	–	–	–	–	–	–	1	–	–
Melanthium	–	–	–	–	–	–	1	–	–
Veratrum	–	–	–	–	–	–	1	–	–
Uvularia	–	–	–	–	–	–	2	–	–
Oakesia	–	–	–	–	–	–	1	–	–
Allium	–	–	–	–	–	–	2(1)	–	–
Hemerocallis	–	–	–	–	–	–	(1)	–	–
Lilium	–	–	–	–	–	–	3	–	–
Erythronium	–	–	–	–	–	–	1	–	–
Ornithogalum	–	–	–	–	–	–	(1)	–	–
Muscari	–	–	–	–	–	–	(1)	–	–
Asparagus	–	–	–	–	–	–	(1)	–	–
Clintonia	–	–	–	–	–	–	1	–	–
Smilacina	–	–	–	–	–	–	3	–	–
Maianthemum	–	–	–	–	–	1	–	–	–
Streptopus	–	–	–	–	–	–	2	–	–
Polygonatum	–	–	–	–	–	–	2	–	–
Medeola	–	–	–	–	–	–	1	–	–
Trillium	–	–	–	–	–	–	4	–	–
Aletris	–	–	–	–	–	–	1	–	–
Smilax	–	–	3	–	–	1	–	–	–
Haemodoraceae	–	–	–	–	–	1	–	–	–
Lachnanthes	–	–	–	–	–	1	–	–	–
Dioscoreaceae	–	–	–	–	–	–	1	–	–
Dioscorea	–	–	–	–	–	–	1	–	–
Amaryllidaceae	–	–	–	–	–	–	1	–	–
Hypoxis	–	–	–	–	–	–	1	–	–
Iridaceae	–	–	–	–	–	4	2	–	–
Iris	–	–	–	–	–	–	2	–	–
Sisyrinchium	–	–	–	–	–	4	–	–	–
Orchidaceae	–	–	–	–	–	11	29	–	–
Cypripedium	–	–	–	–	–	–	3	–	–
Orchis	–	–	–	–	–	–	1	–	–
Habenaria	–	–	–	–	–	–	13	–	–

Orchidaceae—cont.	Mg	Ms	M	N	Ch	H	G	HH	T
Pogonia	–	–	–	–	–	–	4	–	–
Calopogon	–	–	–	–	–	–	1	–	–
Arethusa	–	–	–	–	–	–	1	–	–
Spiranthes	–	–	–	–	–	6	–	–	–
Epipactis	–	–	–	–	–	3	–	–	–
Corallorrhiza	–	–	–	–	–	–	3	–	–
Microstylis	–	–	–	–	–	–	2	–	–
Liparis	–	–	–	–	–	2	–	–	–
Aplectrum	–	–	–	–	–	–	1	–	–
Piperaceae	–	–	–	–	–	–	–	**1**	–
Saururus	–	–	–	–	–	–	–	1	–
Salicaceae	–	**6(4)**	**8**	**4**	–	–	–	–	–
Salix	–	1(2)	8	4	–	–	–	–	–
Populus	–	5(2)	–	–	–	–	–	–	–
Myricaceae	–	–	**1**	**2**	–	–	–	–	–
Myrica	–	–	1	2	–	–	–	–	–
Juglandaceae	**2**	**5**	–	–	–	–	–	–	–
Juglans	1	1	–	–	–	–	–	–	–
Carya	1	4	–	–	–	–	–	–	–
Betulaceae	–	**6**	**5**	–	–	–	–	–	–
Corylus	–	–	2	–	–	–	–	–	–
Ostrya	–	1	–	–	–	–	–	–	–
Carpinus	–	1	–	–	–	–	–	–	–
Betula	–	4	1	–	–	–	–	–	–
Alnus	–	–	2	–	–	–	–	–	–
Fagaceae	**8**	**4**	**2**	–	–	–	–	–	–
Fagus	1	–	–	–	–	–	–	–	–
Castanea	1	–	–	–	–	–	–	–	–
Quercus	6	4	2	–	–	–	–	–	–
Urticaceae	**1**	**3(1)**	–	–	–	**2**	**3**	–	**2(1)**
Ulmus	1	1	–	–	–	–	–	–	–
Celtis	–	1	–	–	–	–	–	–	–
Cannabis	–	–	–	–	–	–	–	–	(1)
Humulus	–	–	–	–	–	–	1	–	–
Morus	–	1(1)	–	–	–	–	–	–	–
Urtica	–	–	–	–	–	2	–	–	–
Laportea	–	–	–	–	–	–	1	–	–
Pilea	–	–	–	–	–	–	–	–	1
Boehmeria	–	–	–	–	–	–	1	–	–
Parietaria	–	–	–	–	–	–	–	–	1
Santalaceae	–	–	–	–	–	–	**1**	–	–
Comandra	–	–	–	–	–	–	1	–	–
Loranthaceae	–	–	–	–	–	–	–	–	**1**
Arceuthobium	–	–	–	–	–	–	–	–	1
Aristolochiaceae	–	–	–	–	–	**1**	**1**	–	–
Asarum	–	–	–	–	–	1	–	–	–
Aristolochia	–	–	–	–	–	–	1	–	–
Polygonaceae	–	–	–	–	–	**11(3)**	–	–	**11(3)**
Rumex .	–	–	–	–	–	2(3)	–	–	–
Polygonum	–	–	–	–	–	9	1	–	10(3)
Polygonella	–	–	–	–	–	–	–	–	1
Chenopodiaceae	–	–	–	–	–	–	**1**	–	**11(3)**
Chenopodium	–	–	–	–	–	–	–	–	4(3)
Atriplex	–	–	–	–	–	–	–	–	2
Salicornia	–	–	–	–	–	–	1	–	2
Suaeda	–	–	–	–	–	–	–	–	2
Salsola	–	–	–	–	–	–	–	–	1
Amaranthaceae	–	–	–	–	–	–	–	–	**1(3)**
Amaranthus	–	–	–	–	–	–	–	–	(3)
Acnida	–	–	–	–	–	–	–	–	1

	Mg	Ms	M	N	Ch	H	G	HH	T
Phytolaccaceae	–	–	–	–	–	–	1	–	–
Phytolacca	–	–	–	–	–	–	1	–	–
Illecebraceae	–	–	–	–	–	–	–	–	1(1)
Scleranthus	–	–	–	–	–	–	–	–	(1)
Anychia	–	–	–	–	–	–	–	–	1
Aizoaceae	–	–	–	–	–	–	–	–	(1)
Mollugo	–	–	–	–	–	–	–	–	(1)
Caryophyllaceae	–	–	–	–	3(2)	5(5)	1	–	8(5)
Spergularia	–	–	–	–	–	–	–	–	3(1)
Spergula	–	–	–	–	–	–	–	–	(1)
Sagina	–	–	–	–	–	1	–	–	1
Arenaria	–	–	–	–	2	2	1	–	–
Stellaria	–	–	–	–	(1)	(1)	–	–	2(1)
Cerastium	–	–	–	–	1(1)	–	–	–	1(1)
Lychnis	–	–	–	–	–	–	(2)	–	–
Silene	–	–	–	–	–	2(1)	–	–	1
Saponaria	–	–	–	–	–	(1)	–	–	–
Dianthus	–	–	–	–	–	–	–	–	(1)
Portulacaceae	–	–	–	–	–	–	2	–	(1)
Claytonia	–	–	–	–	–	–	2	–	–
Portulaca	–	–	–	–	–	–	–	–	(1)
Ceratophyllaceae	–	–	–	–	–	–	–	1	–
Ceratophyllum	–	–	–	–	–	–	–	1	–
Nymphaeaceae	–	–	–	–	–	–	–	6	–
Nymphaea	–	–	–	–	–	–	–	2	–
Castalia	–	–	–	–	–	–	–	2	–
Nelumbo	–	–	–	–	–	–	–	1	–
Brasenia	–	–	–	–	–	–	–	1	–
Ranunculaceae	–	–	2	–	–	25(2)	6	3	2
Ranunculus	–	–	–	–	–	11(2)	–	3	2
Thalictrum	–	–	–	–	–	4	–	–	–
Anemonella	–	–	–	–	–	–	1	–	–
Hepatica	–	–	–	–	–	2	–	–	–
Anemone	–	–	–	–	–	4	1	–	–
Clematis	–	–	2	–	–	–	–	–	–
Caltha	–	–	–	–	–	1	–	–	–
Trollius	–	–	–	–	–	1	–	–	–
Coptis	–	–	–	–	–	1	–	–	–
Aquilegia	–	–	–	–	–	1	–	–	–
Cimicifuga	–	–	–	–	–	–	1	–	–
Actaea	–	–	–	–	–	–	2	–	–
Hydrastis	–	–	–	–	–	–	1	–	–
Magnoliaceae	1	–	–	–	–	–	–	–	–
Liriodendron	1	–	–	–	–	–	–	–	–
Menispermaceae	–	–	–	–	1	–	–	–	–
Menispermum	–	–	–	–	1	–	–	–	–
Berberidaceae	–	–	(1)		–	–	2	–	–
Podophyllum	–	–	–	–	–	–	1	–	–
Caulophyllum	–	–	–	–	–	–	1	–	–
Berberis	–	–	(1)	–	–	–	–	–	–
Lauraceae	–	1	1	–	–	–	–	–	–
Sassafras	–	1	–	–	–	–	–	–	–
Benzoin	–	–	1	–	–	–	–	–	–
Papaveraceae	–	–	–	–	–	(1)	1	–	–
Sanguinaria	–	–	–	–	–	–	1	–	–
Chelidonium	–	–	–	–	–	(1)	–	–	–
Fumariaceae	–	–	–	–	–	2	2	–	–
Adlumia	–	–	–	–	–	1	–	–	–

Fumariaceae—cont.	Mg	Ms	M	N	Ch	H	G	HH	T
Dicentra	–	–	–	–	–	–	2	–	–
Corydalis	–	–	–	–	–	1	–	–	–
Cruciferae	–	–	–	–	–	13(6)	7(1)	(1)	3(6)
Draba	–	–	–	–	–	–(1)	–	–	1
Lepidium	–	–	–	–	–	(1)	–	–	1
Capsella	–	–	–	–	–	–	–	–	(1)
Cakile	–	–	–	–	–	–	–	–	1
Raphanus	–	–	–	–	–	(1)	–	–	–
Brassica	–	–	–	–	–	–	–	–	(3)
Diplotaxis	–	–	–	–	–	(1)	–	–	–
Sisymbrium	–	–	–	–	–	–	–	–	(2)
Erysimum	–	–	–	–	–	1	–	–	–
Radicula	–	–	–	–	–	1(1)	(1)	(1)	–
Barbarea	–	–	–	–	–	1(1)	–	–	–
Dentaria	–	–	–	–	–	–	5	–	–
Cardamine	–	–	–	–	–	3	2	–	–
Arabis	–	–	–	–	–	7	–	–	–
Capparidaceae	–	–	–	–	–	–	–	–	1
Polanisia	–	–	–	–	–	–	–	–	1
Sarraceniaceae	–	–	–	–	–	1	–	–	–
Sarracenia	–	–	–	–	–	1	–	–	–
Droseraceae	–	–	–	–	–	2	–	–	–
Drosera	–	–	–	–	–	2	–	–	–
Podostemaceae	–	–	–	–	–	–	–	1	–
Podostemum	–	–	–	–	–	–	–	1	–
Crassulaceae	–	–	–	–	(1)	1(1)	–	–	1
Penthorum	–	–	–	–	–	1	–	–	–
Tillaea	–	–	–	–	–	–	–	–	1
Sedum	–	–	–	–	(1)	(1)	–	–	–
Saxifragaceae	–	–	–	6(1)	–	9	–	–	–
Saxifraga	–	–	–	–	–	2	–	–	–
Tiarella	–	–	–	–	–	1	–	–	–
Heuchera	–	–	–	–	–	1	–	–	–
Mitella	–	–	–	–	–	3	–	–	–
Chrysosplenium	–	–	–	–	–	1	–	–	–
Parnassia	–	–	–	–	–	1	–	–	–
Ribes	–	–	–	6(1)	–	–	–	–	–
Hamamelidaceae	1	–	1	–	–	–	–	–	–
Hamamelis	–	–	1	–	–	–	–	–	–
Liquidambar	1	–	–	–	–	–	–	–	–
Platanaceae	1	–	–	–	–	–	–	–	–
Platanus	1	–	–	–	–	–	–	–	–
Rosaceae	–	5(1)	28(1)	13(2)	1	39(1)	–	–	1
Physocarpus	–	–	1	–	–	–	–	–	–
Spiraea	–	–	–	2	–	–	–	–	–
Pyrus	–	1	1	1	–	–	–	–	–
Amelanchier	–	1	2	1	–	–	–	–	–
Crataegus	–	–	21	–	–	–	–	–	–
Fragaria	–	–	–	–	–	2	–	–	–
Waldsteinia	–	–	–	–	–	1	–	–	–
Potentilla	–	–	–	1	1	6	–	–	1
Filipendula	–	–	–	–	–	(1)	–	–	–
Geum	–	–	–	–	–	5	–	–	–
Rubus	–	–	–	–	–	18	–	–	–
Dalibarda	–	–	–	–	–	1	–	–	–
Agrimonia	–	–	–	–	–	5	–	–	–
Sanguisorba	–	–	–	–	–	1	–	–	–
Rosa	–	–	–	5(2)	–	–	–	–	–
Prunus	–	3(1)	3(1)	3	–	–	–	–	–

	Mg	Ms	M	N	Ch	H	G	HH	T
Leguminosae	(1)	(2)	–	–	1	30(7)	2	–	4(6)
Gleditsia	(1)	–	–	–	–	–	–	–	–
Cassia	–	–	–	–	–	1	–	–	2
Baptisia	–	–	–	–	–	1	–	–	–
Crotalaria	–	–	–	–	–	–	–	–	1
Lupinus	–	–	–	–	–	1	–	–	–
Trifolium	–	–	–	–	–	(3)	–	–	(3)
Melilotus	–	–	–	–	–	(2)	–	–	–
Medicago	–	–	–	–	–	–	–	–	(1)
Tephrosia	–	–	–	–	–	1	–	–	–
Robinia	–	(2)	–	–	–	–	–	–	–
Coronilla	–	–	–	–	–	(1)	–	–	–
Desmodium	–	–	–	–	–	13	–	–	–
Lespedeza	–	–	–	–	–	10	–	–	–
Vicia	–	–	–	–	–	(1)	–	–	(2)
Lathyrus	–	–	–	–	–	1	1	–	–
Apios	–	–	–	–	–	–	1	–	–
Phaseolus	–	–	–	–	1	–	–	–	–
Strophostyles	–	–	–	–	–	–	–	–	1
Amphicarpa	–	–	–	–	–	2	–	–	–
Linaceae	–	–	–	–	–	4	–	–	1
Linum	–	–	–	–	–	4	–	–	1
Oxalidaceae	–	–	–	–	–	1	2	–	2
Oxalis	–	–	–	–	–	1	2	–	2
Geraniaceae	–	–	–	–	–	2	–	–	2
Geranium	–	–	–	–	–	2	–	–	2
Rutaceae	–	–	–	1	–	–	–	–	–
Zanthoxylum	–	–	–	1	–	–	–	–	–
Simarubaceae	–	(1)	–	–	–	–	–	–	–
Ailanthus	–	(1)	–	–	–	–	–	–	–
Polygalaceae	–	–	–	–	–	2	1	–	4
Polygala	–	–	–	–	–	2	1	–	4
Euphorbiaceae	–	–	–	–	–	(1)	–	–	7
Crotonopsis	–	–	–	–	–	–	–	–	1
Acalypha	–	–	–	–	–	–	–	–	2
Euphorbia	–	–	–	–	–	(1)	–	–	4
Callitrichaceae	–	–	–	–	–	–	–	2	1
Callitriche	–	–	–	–	–	–	–	2	1
Limnanthaceae	–	–	–	–	–	–	–	–	1
Floerkea	–	–	–	–	–	–	–	–	1
Anacardiaceae	–	1	4	1	–	–	–	–	–
Rhus	–	1	4	1	–	–	–	–	–
Aquifoliaceae	–	2	3	1	–	–	–	–	–
Ilex	–	2	2	1	–	–	–	–	–
Nemopanthus	–	–	1	–	–	–	–	–	–
Celastraceae	–	–	1	–	–	–	–	–	–
Celastrus	–	–	1	–	–	–	–	–	–
Staphyleaceae	–	–	1	–	–	–	–	–	–
Staphylea	–	–	1	–	–	–	–	–	–
Aceraceae	3	2	1	–	–	–	–	–	–
Acer	3	2	1	–	–	–	–	–	–
Balsaminaceae	–	–	–	–	–	–	–	–	2
Impatiens	–	–	–	–	–	–	–	–	2
Rhamnaceae	–	–	(1)	2	–	–	–	–	–
Rhamnus	–	–	(1)	1	–	–	–	–	–
Ceanothus	–	–	–	1	–	–	–	–	–
Vitaceae	–	6	–	–	–	–	–	–	–
Psedera	–	2	–	–	–	–	–	–	–
Vitis	–	4	–	–	–	–	–	–	–

	Mg	Ms	M	N	Ch	H	G	HH	T	S
Tiliaceae	1	1	–	–	–	–	–	–	–	
Tilia	1	1	–	–	–	–	–	–	–	
Malvaceae	–	–	(1)	–	–	1(1)	–	(1)	(1)	
Abutilon	–	–	–	–	–	–	–	–	(1)	
Althaea	–	–	–	–	–	–	–	(1)	–	
Malva	–	–	–	–	–	(1)	–	–	–	
Hibiscus	–	–	(1)	–	–	1	–	–	–	
Hypericaceae	–	–	–	–	–	10(1)	–	–	1	
Hypericum	–	–	–	–	–	10(1)	–	–	1	
Elatinaceae	–	–	–	–	–	–	–	–	1	
Elatine	–	–	–	–	–	–	–	–	1	
Cistaceae	–	–	–	–	2	8	–	–	–	
Helianthemum	–	–	–	–	–	2	–	–	–	
Hudsonia	–	–	–	–	2	–	–	–	–	
Lechea	–	–	–	–	–	6	–	–	–	
Violaceae	–	–	–	–	–	27	–	–	–	
Viola	–	–	–	–	–	27	–	–	–	
Cactaceae	–	–	–	–	–	–	–	–	–	1
Opuntia	–	–	–	–	–	–	–	–	–	1
Thymelaeaceae	–	–	–	1	–	–	–	–	–	
Dirca	–	–	–	1	–	–	–	–	–	
Lythraceae	–	–	–	–	1	1(1)	–	–	2	
Rotala	–	–	–	–	–	–	–	–	1	
Decodon	–	–	–	–	1	–	–	–	–	
Lythrum	–	–	–	–	–	1(1)	–	–	–	
Cuphea	–	–	–	–	–	–	–	–	1	
Melastomaceae	–	–	–	–	–	–	1	–	–	
Rhexia	–	–	–	–	–	–	1	–	–	
Onagraceae	–	–	–	–	–	16	2	1	2	
Ludvigia	–	–	–	–	–	3	–	1	–	
Epilobium	–	–	–	–	–	6	–	–	–	
Oenothera	–	–	–	–	–	7	–	–	2	
Circaea	–	–	–	–	–	–	2	–	–	
Haloragidaceae	–	–	–	–	–	–	–	7	–	
Myriophyllum	–	–	–	–	–	–	–	6	–	
Proserpinaca	–	–	–	–	–	–	–	1	–	
Araliaceae	–	–	–	–	1	2	2	–	–	
Aralia	–	–	–	–	1	2	–	–	–	
Panax	–	–	–	–	–	–	2	–	–	
Umbelliferae	–	–	–	–	–	20(3)	2	–	1	
Eryngium	–	–	–	–	–	–	1	–	–	
Sanicula	–	–	–	–	–	4	–	–	–	
Hydrocotyle	–	–	–	–	–	2	–	–	–	
Osmorhiza	–	–	–	–	–	2	–	–	–	
Conium	–	–	–	–	–	(1)	–	–	–	
Ptilimnium	–	–	–	–	–	–	–	–	1	
Cicuta	–	–	–	–	–	2	–	–	–	
Sium	–	–	–	–	–	1	–	–	–	
Cryptotaenia	–	–	–	–	–	1	–	–	–	
Zizia	–	–	–	–	–	2	–	–	–	
Taenidia	–	–	–	–	–	1	–	–	–	
Lilaeopsis	–	–	–	–	–	1	–	–	–	
Ligusticum	–	–	–	–	–	1	–	–	–	
Pastinaca	–	–	–	–	–	(1)	–	–	–	
Heracleum	–	–	–	–	–	–	1	–	–	
Conioselinum	–	–	–	–	–	1	–	–	–	
Angelica	–	–	–	–	–	2	–	–	–	
Daucus	–	–	–	–	–	(1)	–	–	–	

	Mg	Ms	M	N	Ch	H	G	HH	T
Cornaceae	–	**2**	**5**	–	–	**1**	–	–	–
Cornus	–	1	5	–	–	1	–	–	–
Nyssa	–	1	–	–	–	–	–	–	–
Ericaceae	–	–	**9**	**15**	**5**	**7**	**3**	–	–
Clethra	–	–	1	–	–	–	–	–	–
Chimaphila	–	–	–	–	–	2	–	–	–
Moneses	–	–	–	–	–	–	1	–	–
Pyrola	–	–	–	–	–	4	–	–	–
Monotropa	–	–	–	–	–	–	2	–	–
Ledum	–	–	–	1	–	–	–	–	–
Rhododendron	–	–	3	2	–	–	–	–	–
Kalmia	–	–	1	2	–	–	–	–	–
Leucothoë	–	–	1	–	–	–	–	–	–
Andromeda	–	–	–	1	–	–	–	–	–
Lyonia	–	–	1	1	–	–	–	–	–
Chamaedaphne	–	–	–	1	–	–	–	–	–
Epigaea	–	–	–	–	1	–	–	–	–
Gaultheria	–	–	–	–	–	1	–	–	–
Arctostaphylos	–	–	–	–	1	–	–	–	–
Chiogenes	–	–	–	–	1	–	–	–	–
Gaylussacia	–	–	–	3	–	–	–	–	–
Vaccinium	–	–	2	4	2	–	–	–	–
Plumbaginaceae	–	–	–	–	–	**1**	–	–	–
Limonium	–	–	–	–	–	1	–	–	–
Primulaceae	–	–	–	–	(1)	**7**(1)	–	**2**	(1)
Hottonia	–	–	–	–	–	–	–	1	–
Samolus	–	–	–	–	–	1	–	–	–
Lysimachia	–	–	–	–	–(1)	3(1)	–	1	–
Steironema	–	–	–	–	–	2	–	–	–
Trientalis	–	–	–	–	–	1	–	–	–
Anagallis	–	–	–	–	–	–	–	–	(1)
Ebenaceae	–	**1**	–	–	–	–	–	–	–
Diospyros	–	1	–	–	–	–	–	–	–
Oleaceae	**1**	**2**	(2)	–	–	–	–	–	–
Fraxinus	1	2	–	–	–	–	–	–	–
Syringa	–	–	–	(1)	–	–	–	–	–
Ligustrum	–	–	–	(1)	–	–	–	–	–
Gentianaceae	–	–	–	–	–	**5**	–	**2**	**2**
Sabatia	–	–	–	–	–	1	–	–	1
Gentiana	–	–	–	–	–	2	–	–	1
Bartonia	–	–	–	–	–	2	–	–	–
Menyanthes	–	–	–	–	–	–	–	1	–
Nymphoides	–	–	–	–	–	–	–	1	–
Apocynaceae	–	–	–	–	(1)	–	**3**	–	–
Vinca	–	–	–	–	(1)	–	–	–	–
Apocynum	–	–	–	–	–	–	3	–	–
Asclepiadaceae	–	–	–	–	–	**5**	**5**	–	–
Asclepias	–	–	–	–	–	5	4	–	–
Acerates	–	–	–	–	–	–	1	–	–
Convolvulaceae	–	–	–	–	–	–	**3**	–	**5**
Ipomoea	–	–	–	–	–	–	1	–	–
Convolvulus	–	–	–	–	–	–	2	–	–
Cuscuta	–	–	–	–	–	–	–	–	5
Polemoniaceae	–	–	–	–	–	**1**	–	–	–
Polemonium	–	–	–	–	–	1	–	–	–
Hydrophyllaceae	–	–	–	–	–	**1**	–	–	–
Hydrophyllum	–	–	–	–	–	1	–	–	–

	Mg	Ms	M	N	Ch	H	G	HH	T
Boraginaceae	–	–	–	–	–	**7(3)**	**(1)**	–	–
Cynoglossum	–	–	–	–	–	2	–	–	–
Lappula	–	–	–	–	–	1	–	–	–
Symphytum	–	–	–	–	–	–	(1)	–	–
Myosotis	–	–	–	–	–	3	–	–	–
Lithospermum	–	–	–	–	–	(2)	–	–	–
Onosmodium	–	–	–	–	–	1	–	–	–
Echium	–	–	–	–	–	(1)	–	–	–
Verbenaceae	–	–	–	–	–	**3**	–	–	–
Verbena	–	–	–	–	–	3	–	–	–
Labiatae	–	–	–	–	–	**28(10)**	**3**	–	**3(1)**
Teucrium	–	–	–	–	–	1	–	–	–
Trichostema	–	–	–	–	–	–	–	–	2
Scutellaria	–	–	–	–	–	3	1	–	–
Marrubium	–	–	–	–	–	(1)	–	–	–
Agastache	–	–	–	–	–	2	–	–	–
Nepeta	–	–	–	–	–	(2)	–	–	–
Prunella	–	–	–	–	–	1	–	–	–
Galeopsis	–	–	–	–	–	–	–	–	(1)
Lamium	–	–	–	–	–	(1)	–	–	–
Leonurus	–	–	–	–	–	(1)	–	–	–
Stachys	–	–	–	–	–	2	1	–	–
Salvia	–	–	–	–	–	1	–	–	–
Monarda	–	–	–	–	–	2(1)	–	–	–
Blephilia	–	–	–	–	–	2	–	–	–
Hedeoma	–	–	–	–	–	–	–	–	1
Satureja	–	–	–	–	–	1	–	–	–
Pycnanthemum	–	–	–	–	–	7	–	–	–
Lycopus	–	–	–	–	–	5	–	–	–
Mentha	–	–	–	–	–	1(4)	–	–	–
Collinsonia	–	–	–	–	–	–	1	–	–
Solanaceae	–	–	–	**(1)**	–	–	**4**	–	**2(2)**
Solanum	–	–	–	(1)	–	–	1	–	1
Physalis	–	–	–	–	–	–	3	–	1
Datura	–	–	–	–	–	–	–	–	(2)
Scrophulariaceae	–	–	–	–	**3**	**18(3)**	–	–	**13(1**
Verbascum	–	–	–	–	–	(2)	–	–	–
Linaria	–	–	–	–	–	1(1)	–	–	–
Scrophularia	–	–	–	–	–	2	–	–	–
Pentstemon	–	–	–	–	–	2	–	–	–
Chelone	–	–	–	–	–	1	–	–	–
Mimulus	–	–	–	–	–	2	–	–	–
Limosella	–	–	–	–	–	–	–	–	1
Ilysanthes	–	–	–	–	–	–	–	–	2
Gratiola	–	–	–	–	–	1	–	–	1
Veronica	–	–	–	–	3	3	–	–	1(1)
Gerardia	–	–	–	–	–	2	–	–	6
Castilleja	–	–	–	–	–	1	–	–	–
Melampyrum	–	–	–	–	–	–	–	–	1
Pedicularis	–	–	–	–	–	2	–	–	–
Rhinanthus	–	–	–	–	–	–	–	–	1
Schwalbea	–	–	–	–	–	1	–	–	–
Lentibulariaceae	–	–	–	–	–	–	–	**10**	–
Utricularia	–	–	–	–	–	–	–	10	–
Orobanchaceae	–	–	–	–	–	–	**3**	–	–
Epifagus	–	–	–	–	–	–	1	–	–
Conopholis	–	–	–	–	–	–	1	–	–
Orobanche	–	–	–	–	–	–	1	–	–

	Mg	Ms	M	N	Ch	H	G	HH	T
Phrymaceae	–	–	–	–	–	–	**1**	–	–
Phryma	–	–	–	–	–	–	1	–	–
Plantaginaceae	–	–	–	–	–	**4(1)**	–	–	**2**
Plantago	–	–	–	–	–	4(1)	–	–	–
Rubiaceae	–	–	**1**	**1**	–	**13(1)**	–	–	**2**
Galium	–	–	–	–	–	11(1)	–	–	1
Diodia	–	–	–	–	–	–	–	–	1
Mitchella	–	–	–	–	1	–	–	–	–
Cephalanthus	–	–	1	–	–	–	–	–	–
Houstonia	–	–	–	–	–	2	–	–	–
Caprifoliaceae	–	**3**	**8(1)**	**5**	**1**	**3**	–	–	–
Diervilla	–	–	–	1	–	–	–	–	–
Lonicera	–	1	1(1)	2	–	–	–	–	–
Linnaea	–	–	–	–	1	–	–	–	–
Triosteum	–	–	–	–	–	3	–	–	–
Viburnum	–	2	5	2	–	–	–	–	–
Sambucus	–	–	2	–	–	–	–	–	–
Valerianaceae	–	–	–	–	–	–	–	–	**1**
Valerianella	–	–	–	–	–	–	–	–	1
Dipsacaceae	–	–	–	–	–	–	(1)	–	–
Dipsacus	–	–	–	–	–	–	(1)	–	–
Cucurbitaceae	–	–	–	–	–	–	–	–	**2**
Sicyos	–	–	–	–	–	–	–	–	1
Echinocystis	–	–	–	–	–	–	–	–	1
Campanulaceae	–	–	–	–	–	–	**3(1)**	–	**1**
Specularia	–	–	–	–	–	–	–	–	1
Campanula	–	–	–	–	–	–	3(1)	–	–
Lobeliaceae	–	–	–	–	–	**4**	–	**1**	**1**
Lobelia	–	–	–	–	–	4	–	1	1
Compositae	–	–	**1**	–	**8(1)**	**113(15)**	**3(1)**	**1**	**23(3)**
Vernonia	–	–	–	–	–	1	–	–	–
Eupatorium	–	–	–	–	–	8	–	–	–
Mikania	–	–	–	–	–	–	1	–	–
Liatris	–	–	–	–	–	–	1	–	–
Chrysopsis	–	–	–	–	–	1	–	–	–
Solidago	–	–	–	–	–	27	–	–	–
Aster	–	–	–	–	–	33	–	–	1
Erigeron	–	–	–	–	–	2	–	–	4
Sericocarpus	–	–	–	–	–	2	–	–	–
Baccharis	–	–	1	–	–	–	–	–	–
Pluchea	–	–	–	–	–	–	–	–	1
Antennaria	–	–	–	–	7	–	–	–	–
Anaphalis	–	–	–	–	–	1	–	–	–
Gnaphalium	–	–	–	–	–	2	–	–	2
Inula	–	–	–	–	–	(1)	–	–	–
Polymnia	–	–	–	–	–	1	–	–	–
Iva	–	–	–	–	1	–	–	–	–
Ambrosia	–	–	–	–	–	–	–	–	2
Xanthium	–	–	–	–	–	–	–	–	3
Heliopsis	–	–	–	–	–	1	–	–	–
Rudbeckia	–	–	–	–	–	1	–	–	–
Helianthus	–	–	–	–	–	6	(1)	–	–
Bidens	–	–	–	–	–	1	–	1	8
Helenium	–	–	–	–	–	1	–	–	–
Achillea	–	–	–	–	–	1	–	–	–
Anthemis	–	–	–	–	–	–	–	–	(1)
Chrysanthemum	–	–	–	–	–	(1)	–	–	–
Tanacetum	–	–	–	–	–	(1)	–	–	–

Compositae—cont.	Mg	Ms	M	N	Ch	H	G	HH	T
Artemisia	–	–	–	–	(1)	1	–	–	–
Tussilago	–	–	–	–	–	–	(1)	–	–
Petasites	–	–	–	–	–	–	1	–	–
Erechtites	–	–	–	–	–	–	–	–	1
Cacalia	–	–	–	–	–	1	–	–	–
Senecio	–	–	–	–	–	3	–	–	–
Arctium	–	–	–	–	–	(2)	–	–	–
Cirsium	–	–	–	–	–	4(1)	–	(1)	–
Cichorium	–	–	–	–	–	(1)	–	–	–
Krigia	–	–	–	–	–	1	–	–	–
Leontodon	–	–	–	–	–	(2)	–	–	–
Tragopogon	–	–	–	–	–	(1)	–	–	–
Taraxacum	–	–	–	–	–	(2)	–	–	–
Sonchus	–	–	–	–	–	(1)	–	–	(2)
Lactuca	–	–	–	–	–	4(1)	–	–	–
Prenanthes	–	–	–	–	–	4	–	–	–
Hieracium	–	–	–	–	–	6(1)	–	–	–

SUMMARY BY DIVISIONS AND CLASSES

	Mg	Ms	M	N	Ch	H	G	HH	T	S	E
Spermatophyta	23(1)	57(9)	85(7)	54(4)	28(6)	718(79)	192(13	124(1)	170(49)	1	1
Gymnospermae	4	7	1	2	—	—	—	—	—	—	—
Angiospermae	19(1)	50(9)	84(7)	52(4)	28(6)	718(79)	192(13)	124(1)	170(49)	1	1
Monocotyledones	—	—	3	—	—	258(10)	124 (7)	85	41(10)	—	—
Dicotyledones	19(1)	50(9)	81(7)	52(4)	28(6)	460(69)	68 (6)	39(1)	129(39)	1	1

SUMMARY BY MINOR GROUPS

Families		121
Genera:		
Native	451	...
Introduced	70	...
Total		521
Species:		
Native	1,453	
Introduced	169	
Total		1,622

IV. GENERAL CONCLUSIONS AND COMPARISONS OF CONNECTICUT WITH OTHER PARTS OF EASTERN NORTH AMERICA.

A. INTRODUCTION AND PLAN OF THIS SECTION.

The work of Raunkiaer and others has shown that the adaptability of the vegetation to the climate of any particular region is reflected by the relative abundance of certain types of life forms. Regions having similar climates are characterized by the prevalence of the same types of life forms, whereas regions which differ from one another in climate have different types predominant in the flora. It follows that to a certain degree, the character of the climate can be judged from the character of the life forms; in short, by the spectrum which these life forms go to build up.

The first object of this section is to formulate the spectrum for Connecticut and discuss its significance in relation to the climate of this region. The second object is to compare the spectrum for Connecticut with that of other sections of the forest region of eastern North America with a view to ascertaining to what extent, if any, differences in climate are reflected by differences in the predominance of certain life forms, the significance of these differences and their bearing on the general physoniogomic and ecological character of the vegetation taken as a whole.

B. THE CONNECTICUT SPECTRUM

Spectra of native and naturalized species. The ecological spectrum[1] of a region is the series of percentages obtained by expressing the relation between the number of species of each life form and the total number of species in the region. Spectra of Connecticut based on native species alone and on a group composed of native and naturalized species are shown in Table 1. In this table is given also the total number of species considered and the actual number of species in each life form. The abbreviations used for the different life forms are tabulated below:

Mg—megaphanerophytes
Ms—mesophanerophytes
M —microphanerophytes
N —nanophanerophytes
Ch —chamaephytes
H —hemicryptophytes

G —geophytes
HH—Helophytes and hydrophytes
T —therophytes
S —succulents
E —epiphytes

Table 1

		Total	Mg	Ms	M	N	Ch	H	G	HH	T	S	E
Native.....	No.	1453	23	57	85	54	28	718	192	124	170	1	1
Species.....	%	100	1.5	3.9	5.8	3.7	1.9	49.4	13.2	8.5	11.7	.06	.06
Native and	No.	1622	24	66	92	58	34	797	205	125	219	1	1
Naturalized	%	100	1.4	4	5.6	3.5	2	49.4	12.6	7.7	13.5	.06	.0

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[1] See p. 25.

Since the inclusion of naturalized species with native species does not materially alter the spectrum, as this table shows, the former have been excluded from consideration in subsequent discussion and tables.

Spectrum interpreted. The spectrum of the Connecticut flora (table 1) shows that herbaceous perennials are of first importance in this region. Hemicryptophytes constitute almost 50% of the species, cryptophytes (G and HH) 21.7%. Thus we see that over 70% of the species belong to this group in which the perennating buds are protected by the substratum. The importance of this group may be still more clearly seen when it is realized that the other life forms comprising all woody plants, which are dominant physiognomically, together with all herbaceous chamaephytes and all annuals, constitute less than 30% of the species represented in the flora. Of these, therophytes and chamaephytes make up 11.7% and 1.9% respectively of the total flora. Phanerophytes, comprising 15% of the total flora, are chiefly of low or medium stature, but a considerable number attain the height of tall trees. Epiphytes and succulents are practically negligible. Thus the flora of Connecticut appears to be dominantly hemicryptophytic with cryptophytes second in importance; chamaephytes are comparatively few; phanerophytes and therophytes, though not dominant with respect to number of species, constitute a prominent part of the flora.

The fact that hemicryptophytes and cryptophytes comprise such an overwhelming percentage of the species of the Connecticut flora indicates a definite adaptation to a season unfavorable for growth. Furthermore the nature of the unfavorable conditions is suggested. In a season unfavorable for growth because of heat and little precipitation, comparatively few hemicryptophytes can live because the perennating buds in the surface layer of the soil can not stand such desiccating conditions. In a season unfavorable for growth because of cold, on the other hand, even though there is little precipitation, these plants thrive because transpiration is too low to injure the perennating buds; at this season additional protection may be given to the buds of hemicryptophytes by a blanket of snow. Hence from a study of the spectrum of Connecticut it is evident that plant-growth is suspended during the unfavorable season because of cold. Finally the presence of a considerable number of phanerophytes, particularly tall trees, points to the fact that the unfavorable season is of no unusual extent or intensity. The large number of hemicryptophytes likewise indicates a season favorable for their development.

Spectrum compared with normal spectrum. It is interesting and significant in studying the climate of this region to compare the spectrum of Connecticut with that of the normal spectrum[1]

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[1] See p. 27.

(table 2) devised by Raunkiaer as a norm of the flowering plants of the world. A comparison of the figures for phanerophytes (F) and chamaephytes shows that the percentages in the Connecticut spectrum fall far below those of the normal spectrum. The percentage of therophytes in the two spectra is essentially the same. The combined percentages of hemicryptophytes and cryptophytes in the Connecticut spectrum are more than double that of the normal spectrum, these two groups being the only ones which equal it. Such a distribution of life forms, as Raunkiaer (1908)[1] has shown, indicates a climate of considerable rigor in the unfavorable season.

Table 2

	F	Ch	H	K	T
Normal spectrum.........	46	9	26	6	13
Connecticut spectrum.....	15	1.9	49.4	21.7	11.7

Indication as to climate zone. The relation of the climate of Conecticut to that of the world is made evident by comparing the spectrum of Connecticut with a series of spectra prepared by Raunkiaer (table 3). In this series, the spectra are arranged in four groups as regards the life form which is dominant. In the first of these, phanerophytes are dominent; in the second, hemicryptophytes in the third, therophytes; in the fourth, hemicryptophytes, with a high percentage of chamaephytes. The regions thus delimited by their favored life forms, Raunkiaer regards as comprising definitely established zones which he names from the life form in each which is most significant—phanerophytic, hemicryptophytic, therophytic, chamaephytic. The high percentage of hemicryptophytes in the flora of Connecticut places this region with Altamaha, Georgia, and Denmark in the hemicryptophytic zone.

Table 3

	Species	F	Ch	H	K	T
St. Thomas and St. Jan	904	**61**	12	9	4	14
Seychellen	258	**61**	6	12	5	16
Altamaha, Georgia..........	717	23	4	**55**	10	8
Danmark...................	1084	7	3	**50**	22	18
Death Valley	294	26	7	18	7	**42**
Argentario (Italien).........	866	12	6	29	11	**42**
Spitzbergen	110	1	**22**	**60**	15	2
St. Lawrence Island, Alaska..	126	—	**23**	**61**	15	1

Work of Taylor. In thus setting forth the composition of the vegetation of this region by means of life forms, it is necessary to take account of the work done along this same line by Taylor (1915 and 1918). The most comprehensive spectrum which he has formulated is that based on the plants growing within 100 miles of New York. This spectrum is given in Table 4 with spectra for Connecticut, Denmark, and the normal spectrum included for comparison. Considering the fact that Taylor's list includes almost all of the plants of Connecticut, the differences between the spectrum set forth by the writer and that of Taylor are certainly striking. This is particularly true in the case of hemicryptophytes where there is a difference of 16.12% between the two spectra; but is also noteworthy in the large differences in the percentages given for geophytes and chamaephytes. Taylor (1915, p. 27) calls attention to the high percentage of geophytes, saying that "for no region in the world has there been published such a large percentage of these plants with bulbs, rhizomes, corms, and other subterranean methods of winter protection." In the opinion of the writer, this sentence offers the key to the solution of the principal discrepancy existing between the two spectra. Taylor seems to class all plants which have rhizomes as geophytes. This is borne out in his few and incomplete published lists (1915, pp. 29, 31) where Viola spp., Hypericum Bissellii, H. punctatum, H. virginianum and H. virgatum are classed as geophytes. As a matter of fact, in very many such plants the rhizome comes to the surface of the soil and there produces the perennating bud; these plants should be classed as hemicryptophytes. This is recognized by Raunkiaer who classes such plants as Lysimachia vulgaris, Saponaria officinalis, Viola spp., etc. as hemicryptophytes with running branches. Hypericum perforatum, cited by Taylor as a geophyte, is classed by Raunkiaer as a protohemicryptophyte without running branches. Of the seventeen species definitely cited by him as geophytes, it is probable that only four belong to this group. These is little question that a large proportion of the plants on which the figure 20.23% is based, should be transferred to the hemicryptophyte column, thus bringing that group more nearly to the figure given for hemicryptophytes in the Connecticut spectrum. Combining hemicryptophytes and cryptophytes (table 5), there is not much difference in the figures for Connecticut and New York, Moreover, the figure given for chamaephytes by

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[1] See review by Smith. Journ. Ecol. 1, pp. 19–20.

Table 4

	Mg	Ms	M	N	Ch	H	G	HH	T
Taylor Local Flora......	.52	4.03	7.18	3.51	5.29	33.29	20.23	11.74	13.0
Ennis Connecticut......	1.58	3.92	5.85	3.71	1.92	49.41	13.21	8.5	11.7
Raunkiaer Denmark........	1	—	3	3	3	50	11	11	18
Normal Spectrum........	46				9	26		6	13

Taylor is probably too high. In his published lists, thirteen species are classed as chamaephytes. Five of these—Fragaria vesca var. americana, F. virginiana, F. canadensis, F. terranovae, Hypericum adpressum,—might better be classed as hemicryptophytes. Indeed Fragaria spp. are mentioned by Raunkiaer as typical hemicryptophyte rosette plants with running branches. The percentages of phanerophytes and therophytes in the two spectra agree fairly well. Comparing the spectra of Connecticut and Denmark, we find a close agreement exsting between the hemicryptophyte and cryptophyte groups, while, as we should expect, the percentage of phanerophytes is lower in Denmark, which is 10° farther north. In all three spectra, we find that the percentage of hemicryptophytes exceeds that given in the normal spectrum while the percentage of phanerophytes is far below it. This indicates a definite winter season in all of these regions. It is noteworthy that a considerable difference in the determination of the life forms of a region does not materially alter the deduction as to the outstanding features of climate. One may say that in this respect spectra are practically fool proof.

Table 5

	F	Ch	H, G, HH	T
Local flora.......	15.24	5.29	65.26	13
Connecticut......	15.06	1.92	71.12	11.7
Denmark........	7	3	72	18
Normal spectrum.	46	9	32	13

Taylor's criticism of the normal spectrum (1918, pp. 488-491) as placing the herbaceous element of the world flora too low, seems to deserve mention in this place. The percentage given for geophytes seems to him decidedly weak in comparison with the percentages which he has obtained; also the total percentage allowed by Raunkiaer for all herbaceous plants (48%) seems entirely too low in comparison with the same group in the local flora area (79%), all Long Island (83%), and in the 400 commonest species of Long Island (78%). Furthermore, he has pointed out that a careful study of the percentages of herbaceous plants in temperate and tropical regions based on calculations of Sinnott and Bailey[1] indicates about 58% of herbs as against 42% woody plants. In Raunkiaer's latest work on the normal spectrum (1918, p. 17), 49% or 50% are allowed for herbaceous plants, leaving 8% or 9% difference between the percentage allowed by Raunkiaer for the herbaceous plants of the world and that estimated by Taylor. This difference in percentage should be distributed among five life forms of the normal spectrum; but even if it were added to any one of these five, it would not change our interpretation of the outstanding climate of any region. Since this is true, the criticism of Taylor appears to be of minor importance.

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[1] Sinnott, E. W., and Bailey, I. W. The origin and dispersal of herbaceous angiosperms. Ann. Bot. 28: 566-567. 1914.

C. Comparison of Connecticut Spectrum with Spectra of other Parts of Eastern North America

Spectra of representative sections prepared. We now approach the second object of the section—that of comparing the spectrum of Connecticut with spectra of other sections of the forest region of eastern North America with a view to ascertaining to what extent differences in climate are reflected by differences in the predominance of certain life forms. For this purpose, there have been prepared spectra of Mississippi, Alabama, and Cape Breton which, together with that of Connecticut, define the eastern limits of this region; and also the spectrum of Iowa which marks the western boundary. In all of these sections, the topography is such that little change in the character of the vegetation results from altitude, and, in the deductions that are drawn, this is not taken into consideration. In the study of the Alabama region, Mohr's *Plant Life of Alabama* has been used; of the Mississippi region, Lowe's *Plants of Mississippi*; of the Iowa region, Greene's *Plants of Iowa*. Since there is no catalogue of the plants of a northern section comparable to that of Connecticut, Mississippi, Alabama, and Iowa, it was necessary to compile a list from such sources as were available. Cape Breton, an area almost as far north of Connecticut as Mississippi and Alabama are south, was taken for this purpose. In addition to the published works of Macoun and Robinson, use has been made of manuscripts lists furnished by Dr. G. E. Nichols, Hon. J. R. Churchill, Miss Margaret Brown, and Mr. James Macoun. The list obtained from these sources undoubtedly contains at least most of the common plants of the region, though it can not lay claim to the completeness of the Connecticut catalogue. Since woody plants are more evident than annuals and herbaceous perennials, that group is probably more nearly complete than the others.

Similarity of spectra. At first glance, the most striking fact revealed by the spectra of the regions considered (table 6) is their great similarity. In hemicryptophytes, for example, the percentage recorded for Mississippi and that for Connecticut are practically the same, and there is a range of only 3.5% in all the spectra. In geophytes, there is a range of 2.9%, in chamaephytes 2%, in phanerophytes 3.7%. This similarity might be quite disconcerting to one who wished to show, by means of spectra, important

Table 6

	Species	Mg	Ms	M	N	Ch	H	G	HH	T
Mississippi.......	1724	3.5	5.4	4.6	4.2	3.1	49.4	12.4	3.8	12.8
Alabama.........	2012	2.9	4.8	4.6	4.7	3.1	47.8	12.8	4.3	14.4
Connecticut......	1453	1.5	3.9	5.8	3.7	1.9	49.4	13.2	8.5	11.7
Iowa............	1320	2.2	3.7	4.8	4.1	1	48.6	15.3	5.6	14.2
Cape Breton.....	637	1.4	2.9	3.7	6.1	1.8	51.3	15.3	10.3	6.7

climatic differences in these widely separated regions. Moreover, if we compare these spectra with the normal spectrum, we see that the high percentage of hemicryptophytes in all of the regions considered indicates the same general type of climate. As we have seen above, hemicryptophytes are characteristic of regions which have a period unfavorable for plant growth represented by winter. This is borne out by the fact that in the whole area extending from Alabama and Mississippi to Cape Breton and west to Iowa, there is a definite winter period of sufficient intensity to cause the suspension of all growth. This seems of particular value in arriving at a true understanding of the climate of the region.

Significant differences. After noting the resemblances, upon closer examination, differences are revealed which are probably significant. In geophytes and the group composed of helophytes and hydrophytes, there is a variation of 2.9% and 6.5% respectively in the spectra of Mississippi and Cape Breton. Combining these three life forms to comprise a group of cryptophytes, the difference is still more striking (table 7). From Mississippi to Cape Breton there is a constantly increasing percentage with a difference of 9.4% between the sections farthest north and south respectivelty. Again, combining hemicryptophytes with cryptophytes, we have a group including all plants whose perennating buds are protected by the substratum. The percentage of this group increases from 65% in Alabama to 76.6% in Cape Breton. This amount of variation, though comparatively small, is far beyond the range of error. Certainly it is indicative of an increase in the severity of winter conditions. A consideration of the other life forms (table 6) is not without fruitful result. The percentage of phanerophytes decreases 3.19% from Mississippi to Connecticut, .51% from Connecticut to Cape Breton. This last figure is too small to denote any climatic difference, since that small percentage might easily come within the range of error. However, keeping in mind what has been pointed out above—that data for the group of phanerophytes is probably more nearly complete than that of any other in the Cape Breton flora—we conclude that probably the percentage for Cape Breton is too high. This being the case, there might easily be as great a difference in the percentage of phanerophytes of Connecticut and Cape Breton as there is between those of Connecticut and Mississippi. However that may be, the difference shown by the figures indicates an increase in the severity

Table 7

	H. G. HH	G, HH
Mississippi	65.77	16.29
Alabama	65	17.14
Connecticut	71.16	21.74
Iowa	69.62	20.98
Cape Breton	76.62	25.74

of winter in regions successively farther north. The fact that the bulk of the phanerophytes of Mississippi and Alabama are tall or of medium height, while those of Cape Breton are small trees or shrubs, bears witness to the same conclusion. The low percentage of therophytes in Cape Breton as compared with Alabama suggests a correspondingly shorter growing season in the north.

Finally we come to the consideration of chamaephytes. It is of particular interest to find that this group shows a decreasing percentage from Alabama to Connecticut when from the form[1] of these plants one might expect just the reverse. In this connection it has seemed desirable to inquire into the nature of the chamaephytes in the regions under consideration. The results of this investigation are shown in Table 8 where the composite nature of the group in the different regions is evident. The percentage of the semi-shrubby chamaephytes varies from 2.18% of the total flora in Alabama to .15% in Cape Breton, while the percentage of active and passive chamaephytes in the same regions varies from .81% to 1.72%, respectively. Their relation to each other may be more clear when we say that over 70% of the chamaephytes of Alabama are semi-shrubby; over 90% of the chamaephytes of Cape Breton are active or passive. The high percentage of active and passive chamaephytes in Cape Breton represents an adaptation to a long winter with snow and a short growing season. Being prostrate or practically so, they are perfectly protected during the resting period, while as soon as the snow melts off they are ready to bloom without first producing a vegetative body. Epigaea, which blooms when the snow is scarcely off the ground, is a good example of such plants. It is noteworthy that so many of them are evergreen. The high percentage of semi-shrubby chamaephytes in Alabama may be the resultant of forces acting on two different kinds of plants—tropical shrubs which here become semi-shrubby northward, and northern hemicryptophytes which here become semi-shrubby southward. Croton punctatus, Jatropha stimulosa and Solanum aculeatissimum are examples of the first group; Oxalis cymosa and Hypericum cistifolium, of the second. Probably a

Table 8

Chamaephytes

	Total Species		Evergreen Species		Semi-shrubby		Passive		Active		Active and Passive
	No.	%	No.	%	No.	%	No.	%	No.	%	%
Cape Breton..	12	1.88	10	1.57	1	.157	6	.94	5	.78	1.72
Connecticut...	28	1.9	16	1.1	5	.34	18	1.23	5	.34	1.58
Mississippi....	53	3	4	.23	37	2.14	11	.63	5	.29	.92
Alabama......	61	3	5	.24	44	2.18	12	.57	5	.24	.81
Iowa.........	14	1	4	.3	7	.53	5	.38	2	.15	.53

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[1] See p. 15.

number of plants of the second group have not been recognized as chamaephytes at all. If this is true, the figures for semi-shrubby chamaephytes should be even higher. The large number of semi-shrubby chamaephytes with a range extending from the latitude of North Carolina to the Gulf States suggests that this type of vegetation is very well adapted to the climate. The higher percentage of chamaephytes toward the South is in agreement with the work of Raunkiaer, who found that chamaephytes, though particularly characteristic of the far north, where they compose 30%, 50% or even 100% of the flora, also occur in considerable numbers in the tropics (table 3, spectrum of St. Thomas and St. Jan); in temperate regions they are less abundant. This study of chamaephytes leads us to believe that the species of Cape Breton are more perfectly adapted to winter conditions than are those of the South. We may say, therefore, that all these latter comparisons agree with those made in the case of hemicryptophytes in showing that within these regions, which have the same general type of climate, there are differences which indicate a slow but definite increase in the severity of winter conditions.

Summary. In summarizing the importance of spectra as indicators of climate, it must be emphasized that their primary and most obvious value is that of showing the big outstanding climatic regions—those characterized by uniformity of climate, by climatic extremes, by desert conditions, etc. Their secondary value is to a certain extent that of an indicator of lesser climatic differences within the climate zones; this has been shown in their indication through the life forms of a steadily increasing rigor of climate in direct proportion to degrees of latitude.

D. Spectra of Phanerophytes of Connecticut Compared with those of other Parts of Eastern North America.

Reasons for investigation. The question now arises as to whether there is not some way in which the ecological spectrum, either as a whole or in part, may show the lesser climatic differences more convincingly. We have seen that the climate of the whole eastern part of North America is characterized by a cold season of sufficient intensity to cause plants to enter upon a definite resting period and that it is chiefly in the severity and length of the cold season that the various sections differ. It might well be expected that such climatic differences will be registered primarily by those plants which remain alive above the surface of the ground in winter—all woody plants and a few herbaceous chamaephytes. Of these, those which grow highest above the ground should most plainly show the effect of rigorous conditions. Accordingly, a thorough investigation of the group of phanerophytes will probably be most fruitful.

Analysis with respect to form of growth. In the first place, phanerophytes exhibit three forms of growth—tree, shrub and vine; in the second place, some retain their leaves during the winter; others drop them at the beginning of the cold season. Both of these peculiarities of life form seem to be significant.

The analysis according to the form of growth exhibited by phanerophytes of the regions under consideration is shown in Table 9. The scheme here followed differs from that of Raunkiaer chiefly in its taking account of the woody vines. Also those plants called shrubs by the manuals of the regions under consideration are classed as such even though their height exceeds two meters, which is the upper limit of Raunkiaer's lowest group of phanerophytes. Plants described in the manuals as shrub or small tree are included with trees. In this table, we see that both in number of species of trees and in their percentage in proportion to the flora as a whole, there is a gradual decrease in regions successively farther North. The number of species of shrubs decreases less rapidly and their percentage in proportion to the number of species in the whole flora actually increases. Woody vines decrease in number from 47 in Alabama to 3 in Cape Breton and in proportion to the total flora from 2.43% to .47%. This division, since it considers woody vines as a separate group, brings out the character of the woody plants more specifically than that of Raunkiaer.

Table 9

	Total		Trees		Shrubs		Woody Vines	
	No.	%	No.	%	No.	%	No.	%
Mississippi.......	310	17.98	185	10.73	83	4.81	42	2.43
Alabama.........	347	17.24	189	9.37	111	5.51	47	2.33
Connecticut......	219	15.07	115	7.91	89	6.12	15	1.03
Cape Breton.....	91	14.28	39	6.12	49	7.69	3	.47
Iowa............	198	15	112	8.48	64	4.84	22	1.66

Table 10

	Evergreen Species						Deciduous Species					
	Trees		Shrubs		Vines		Trees		Shrubs		Vines	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Mississippi..	34	1.97	12	.69	7	.2	151	8.75	71	4.12	35	1.8
Alabama....	40	1.98	12	.59	9	.44	149	7.4	99	4.92	38	1.88
Connecticut .	13	.9	8	.55	0	0	102	7.01	81	5.57	15	1.03
Cape Breton.	7	1.09	8	1.25	0	0	32	5.02	41	6.43	3	.47
Iowa........	4	.3	1	.07	0	0	108	8.18	63	4.17	22	1.66

Analysis with respect to evergreen character. The relation between deciduous and evergreen species of woody plants is set forth in Table 10. Here interesting differences in the composition of the phanerophytes of the different sections are made evident. In Connecticut, for example, there are fewer evergreen trees and shrubs than in Mississippi and Alabama to the south, on the one hand, and Cape Breton to the north, on the other. In order to understand the significance of this, we must make a distinction between broad-leaved and narrow leaved evergreen species (conifers). The proportion of conifers in the regions under consideration is set forth in Table 11. Proceeding northward from Mississippi to Cape Breton, there is a definite increase in the percentage of conifers. In Mississippi, conifers constitute 4.8% of all woody plants; in Cape Breton, 18%. Thus we see that while in the south from the standpoint of total number of species in the flora, these plants are of relatively small inportance, in northern regions they form an important part of the flora. Turning next to the consideration of broad-leaved evergreens (table 12), a great contrast is evident. This group makes a good showing in our southern states; in Connecticut, it has been reduced to a place of very minor importance; in Cape Breton, tree species are entirely lacking. A consideration of the facts set forth by these last two tables, throws considerable light on the question raised by the consideration of Table 10—why Connecticut has a smaller percentage of evergreen species than Mississippi and Cape Breton. Toward the north, conifers increase in number of species proportionately to the total number of woody plants; broad-leaved evergreens, on the other hand, decrease in number in proportion to the total number of woody plants and finally disappear entirely due to increasingly unfavorable climatic conditions. From this, it is plain that Connecticut lies in the transition field between the region favorable for the development of broad-leaved evergreen species and the region most favorable for the development of conifers. This relation between conifers and broad-leaved evergreens is clearly set forth in Table 13. In this table, northern Florida, the District of Columbia, New Jersey, and Penobscot Bay have been added for comparative purposes.

Table 11
Evergreen Conifers

	Number	Per cent of Total Flora	Per cent of Woody Plants
Mississippi.....	9	.5	4.8
Alabama.......	11	.5	5.8
Connecticut....	13	.9	9.7
Cape Breton...	10	1.5	18.
Iowa..........	5	.3	3.5

Table 12
Broad-Leaved Evergreens

	Number	Per cent of Total Flora	Per cent of Woody Plants
Mississippi.....	44	2.55	14.2
Alabama.......	50	2.48	14.4
Connecticut....	8	.5	4.
Cape Breton...	4	.6	4.4
Iowa..........	0	0	0

With respect to the percentage of evergreen species in the flora, Iowa falls far below Connecticut (tables 11, 12, 13) having only 2.5% of the woody plants of the region belonging to this group as compared with 10% in Connecticut. In Iowa, broad-leaved evergreen species which make up 4% of the woody plants of Connecticut are entirely lacking, while the percentage of conifers is less than half that of Connecticut. This low percentage of evergreens in the flora of Iowa points to the fact that climatic conditions are there more rigorous for plant life than are those of Connecticut, and this is what one should expect in a continental area. Just what climatic factors limit the growth of evergreen species in Iowa, it is rather difficult to say. The important thing in this connection is that differences in the climate of Iowa and that of Connecticut do exist and that these differences are reflected in their respective floras.

Table 13

	Species Woody Plants	Evergreen Species		Broad-Leaved Evergreens		Evergreen Conifers	
		No.	%	No.	%	No.	%
Florida	357	111	**31**	98	**27.4**	13	**3.6**
Alabama	347	61	**17.6**	50	**14.4**	11	**3.2**
Mississippi	310	53	**17.1**	44	**14.2**	9	**2.9**
District of Columbia	187	20	**10.5**	12	**6.3**	8	**4.2**
New Jersey	183	22	**12**	13	**7**	9	**5**
Connecticut	219	21	**10**	8	**4**	13	**6**
Penobscot Bay	97	16	**16.4**	4	**4.1**	12	**12.3**
Cape Breton	91	14	**15.4**	4	**4.4**	10	**11**
Iowa	198	5	**2.5**	0	**0**	5	**2.5**

Summary. How accurately differences in climate are reflected by differences in life form is evident in the comparison of the spectra of Connecticut and Iowa, as well as in the comparison previously made of the spectra of Connecticut with those of regions to the north and to the south. The climate zone and to a certain extent lesser climatic differences are shown by studying the spectra of all the life forms in the regions under consideration. The lesser differences are more clearly revealed by spectra showing the evergreen element in the woody plants of the regions.

E. Composition of the Upper Levels of the Forest in Various Parts of Eastern North America.

The figures in Tables 11, 12 and 13 have been based upon the composition of all woody plants. Now, according to our statement on page 84, those plants which grow tallest should most plainly show the effect of rigorous conditions. The question now arises as to whether there might not be a difference in the composition of the upper levels of the forest and that of the whole group of woody plants. That such a difference exists, might be inferred from the fact that conifers are dominant physiognomically in the south. Since such a finding might materially affect our conclusions, it has seemed desirable to study the upper levels of the forest in all of the regions we have been considering. Sargent's *Manual of the Trees of North America* has been taken as a basis in determining the height of the various species; then, for each region the height given by Sargent has been checked up with the heights given by the local manuals of that region. Studies have been made at heights of 10, 20, 30, 40 and 50 meters. The results obtained have been set forth in Tables 14-23; also in Tables 24 and 25, which summarize the percentages for conifers and broad-leaved evergreen species repectively in all of the regions.

The percentage of conifers in the south increases steadily from 10 meters to 40 meters, but no species attains the height of 50 meters. In the north, however, the percentage of conifers at 10 meters is almost double that in the south at 40 meters, and two species attain the height of 50 meters. Broad-leaved evergreens are of lower stature, reaching only 30 meters in the south; in the north, they are entirely absent from the flora at 10 meters. These tables show in an even more striking fashion than those previously given that coniferous trees are adapted to the climatic conditions in the north, broad-leaved evergreens, to those of the south, and thus confirms the evidence presented by the spectra of all woody plants as to the response which these plants make to climate.

Table 14

Florida Spectra

	No. Species	Evergreen Species		Broad-Leaved Evergreen Species		Narrow-Leaved Evergreen Species	
		No.	%	No.	%	No.	%
Trees 10 M	129	40	**31**	28	**21.7**	12	**9.3**
20 M	83	23	**27.7**	13	**15.6**	10	**12.1**
30 M	56	14	**25**	6	**10.7**	8	**14.3**
40 M	28	4	**14.3**	0	**0**	4	**14.3**
50 M	12	0	**0**	0	**0**	0	**0**

Table 15

Alabama Spectra

	No. Species	Evergreen Species		Broad-Leaved Evergreen Species		Narrow-Leaved Evergreen Species	
		No.	%	No.	%	No.	%
Trees 10 M	117	28	**23.9**	17	**14.4**	11	**9.5**
20 M	90	21	**23.3**	11	**12.2**	10	**11.1**
30 M	65	14	**21.5**	6	**9.2**	8	**12.3**
40 M	31	4	**13**	0	**0**	4	**13**
50 M	12	0	**0**	0	**0**	0	**0**

Table 16

Mississippi Spectra

	No. Species	Evergreen Species		Broad-Leaved Evergreen Species		Narrow-Leaved Evergreen Species	
		No.	%	No.	%	No.	%
Trees 10 M	119	26	21.8	17	14.2	9	7.6
20 M	90	20	22.2	12	13.3	8	8.9
30 M	65	13	20	6	9.2	7	10.8
40 M	30	4	13.3	0	0	4	13.3
50 M	11	0	0	0	0	0	0

Table 17

District of Columbia Spectra

	No. Species	Evergreen Species		Broad-Leaved Evergreen Species		Narrow-Leaved Evergreen Species	
		No.	%	No.	%	No.	%
Trees 10 M	80	15	18.7	7	8.7	8	10
20 M	62	11	17.7	4	6.4	7	11.3
30 M	47	8	17	2	4.2	6	12.8
40 M	26	3	11.5	0	0	3	11.5
50 M	10	1	10	0	0	1	10

Table 18

New Jersey Spectra

	No. Species	Evergreen Species		Broad Leaved Evergreen Species		Narrow-Leaved Evergreen Species	
		No.	%	No.	%	No.	%
Trees 10 M	76	14	18.4	5	6.6	9	11.8
20 M	55	11	20	3	5.6	8	14.5
30 M	41	8	15.3	1	2.3	7	13
40 M	22	3	13.6	0	0	3	13.6
50 M	10	1	10	0	0	1	10

Table 19

Connecticut Spectra

	No. Species	Evergreen Species		Broad-Leaved Evergreen Species		Narrow-Leaved Evergreen Species	
		No.	%	No.	%	No.	%
Trees 10 M	85	13	15.3	2	2.3	11	13
20 M	60	10	16.6	0	0	10	16.6
30 M	42	8	19	0	0	8	19
40 M	26	4	15.4	0	0	4	15.4
50 M	10	1	10	0	0	1	10

Table 20

Penobscot Bay

	No. Species	Evergreen Species No.	Evergreen Species %	Broad-Leaved Evergreen Species No.	Broad-Leaved Evergreen Species %	Narrow-Leaved Evergreen Species No.	Narrow-Leaved Evergreen Species %
Trees 10 M	36	9	25	0	0	9	25
20 M	27	9	33.3	0	0	9	33.3
30 M	21	8	38	0	0	8	38
40 M	10	4	40	0	0	4	40
50 M	2	1	50	0	0	1	50

Table 21

Cape Breton Spectra

	No. Species	Evergreen Species No.	Evergreen Species %	Broad-Leaved Evergreen Species No.	Broad-Leaved Evergreen Species %	Narrow-Leaved Evergreen Species No.	Narrow-Leaved Evergreen Species %
Trees 10 M	29	7	24	0	0	7	24
20 M	23	7	30.4	0	0	7	30.4
30 M	17	6	35	0	0	6	35
40 M	8	3	33	0	0	3	33
50 M	2	1	50	0	0	1	50

Table 22

Iowa Spectra

	No. Species	Evergreen Species No.	Evergreen Species %	Broad-Leaved Evergreen Species No.	Broad-Leaved Evergreen Species %	Narrow-Leaved Evergreen Species No.	Narrow-Leaved Evergreen Species %
Trees 10 M	79	4	5	0	0	4	5
20 M	59	3	5	0	0	3	5
30 M	40	2	5	0	0	4	5
40 M	23	1	4.3	0	0	1	4.3
50 M	9	1	11.1	0	0	1	11.1

Table 23

Summary of the percentages of conifers in the flora of various sections of eastern North America taken from figures presented in Tables 14-22.

	10 M	20 M	30 M	40 M	50 M
Florida	9.3	12.1	14.3	14.3	0
Alabama	9.5	11.1	12.3	13	0
Mississippi	7.6	8.9	10.8	13.3	0
District of Columbia	10	11.3	12.8	11.5	10
New Jersey	11.8	14.5	13	13.6	10
Connecticut	13	16.6	19	15.4	10
Penobscot	25	33.3	38	40	50
Cape Breton	24	30.4	35	33	50
Iowa	5	5	5	4.3	11.1

Table 24

Summary of the percentages of broad-leaved evergreens in the flora of various sections of eastern North America taken from figures presented in Tables 14-22.

	10 M	20 M	30 M	40 M	50 M
Florida	21.7	15.6	10.7	0	0
Alabama	17	11	6	0	0
Mississippi	17	12	6	0	0
District of Columbia	7	4	2	0	0
New Jersey	5	3	1	0	0
Connecticut	2	0	0	0	0
Penobscot Bay	0	0	0	0	0
Cape Breton	0	0	0	0	0
Iowa	0	0	0	0	0

F. INDICATION OF SPECTRA AS TO CLIMAX FOREST.

The figures just presented seem to throw considerable light on the influence of climate in determining the nature of the ecological climax in different parts of the area. In Connecticut, for example, broad-leaved evergreens are practically negligible; conifers, while not composing a high proportion of any level of the forest, can not be overlooked since they compose almost one-fifth of the trees of 30 meters and include some of the tallest trees; the great bulk of the trees is deciduous. One may say, therefore, that the ecological climax of this region is deciduous forest with an element of conifers. In the south, the percentage of conifers is not high at any level of the forest; the percentage of broad-leaved evergreens is high only at the lower levels, the percentage of deciduous trees is high at all levels. Hence we conclude that the climax forest of this region is chiefly deciduous with an element of broad-leaved evergreens. In the north, the high percentage of conifers at all levels makes it clear that these plants form an important part of the climax forest. In Iowa, the climax forest is evidently deciduous.

In concluding this section, the fact must be emphasized that these studies of the life forms of plants are important in expressing plant climate, not physiognomy. In no case is this more clearly brought out than by the conifers of the southern states which are dominant physiognomically though constituting only about 3% of the woody plants of the region and 14% of tall trees. Such an expression must be the result of edaphic conditions rather than an index of the climatic potentialities of the region.

G. SUMMARY.

1. The spectrum of the Connecticut flora points to the fact that the region is one in which there is a winter of moderate intensity accompanied by a fair amount of precipitation.

2. Spectra of representative sections of the forest region of eastern North America show that the whole area is similar to Connecticut in having a definite winter of sufficient intensity to

cause the suspension of all growth. The whole area is in the hemicryptophytic climate zone.

3. Minor differences in the spectra of these sections reveal the fact that within these sections which have the same general type of climate, there are differences which indicate a slow but definite increase in the severity of winter conditions in regions successively farther north. Differences in the spectra indicate also that winter conditions are more severe in inland regions than in those on the coast.

4. Further differences with respect to the height of trees and the evergreen element in the flora of these sections, bring us to the same conclusions.

5. The percentage of evergreen species in the forests of any section gives an indication as to its climax forest. The climax forest of Connecticut is deciduous with an element of conifers; that of Iowa is deciduous; that of the Gulf States is deciduous with an element of broad-leaved evergreens; that of Cape Breton is deciduous with a high percentage of conifers.

6. The life forms of the plants in the flora of a region present a definite response to the climate of that region. Not only does the spectrum based on these life forms show the outstanding climate of the region but also minor differences between it and other sections which have the same general type of climate.

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PLATE I.

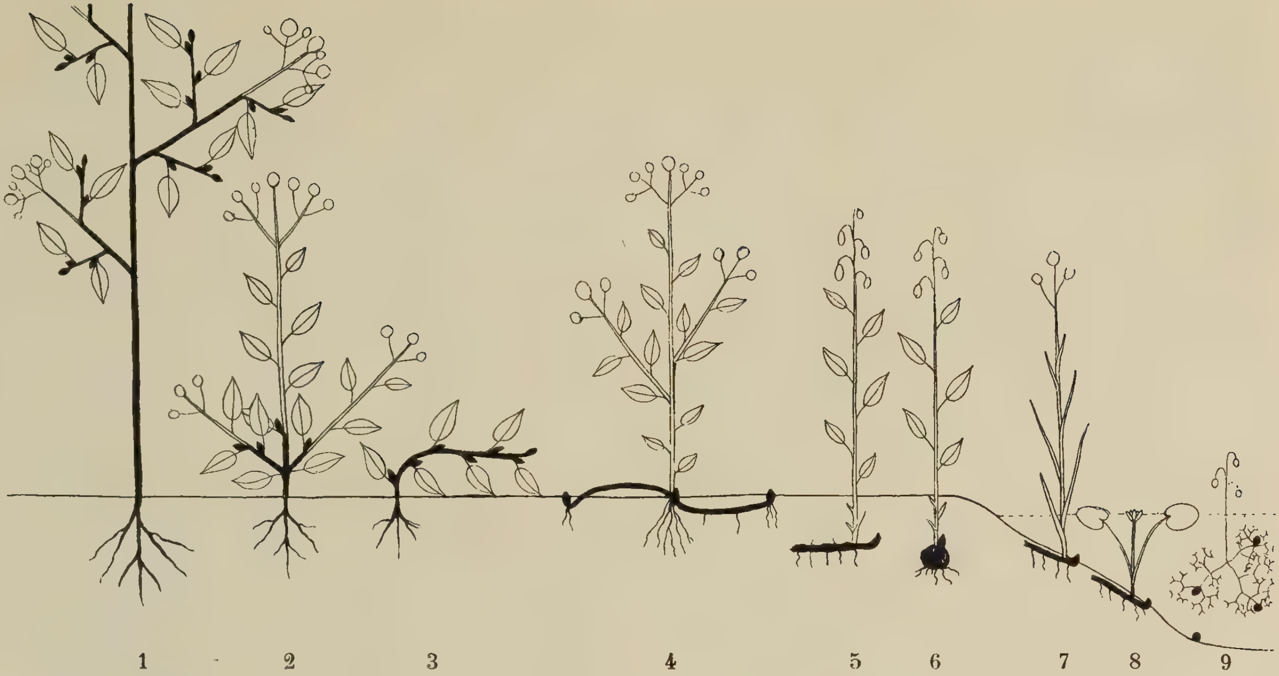

Fig. 1. Diagrammatic representation of the life forms of Raunkiaer: 1, phanerophyte; 2–3, chamaephytes; 4, hemicryptophyte; 5–6, geophytes; 7, helophyte; 8–9, hydrophytes.

PLATE II.

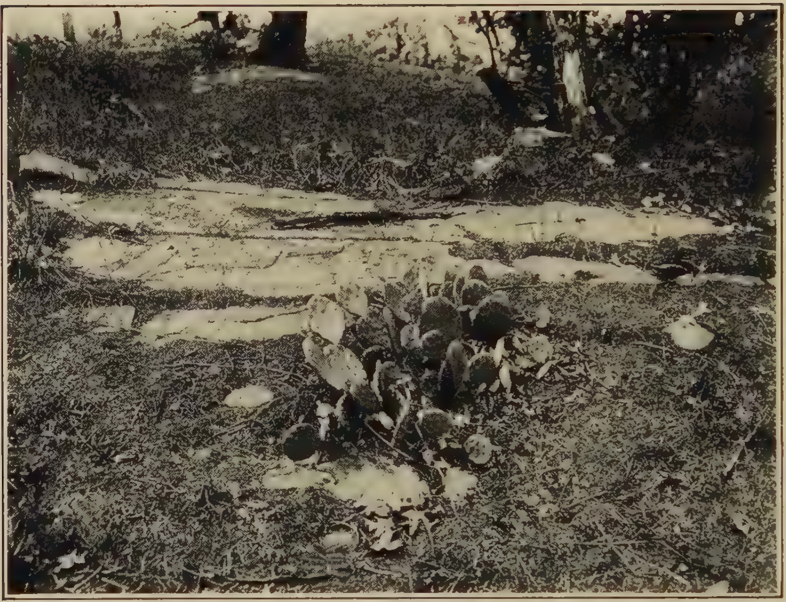

Fig. 2. Opuntia vulgaris, stem succulent.

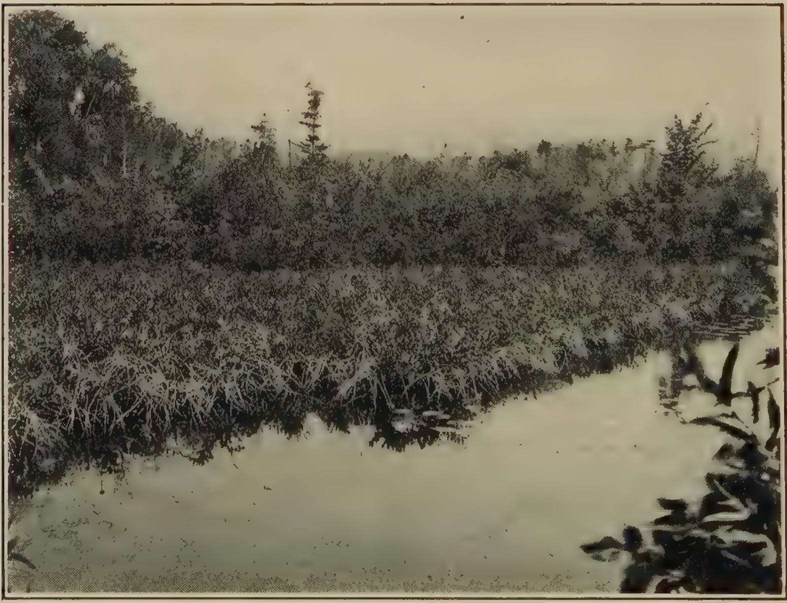

Fig. 3. Decodon verticillatus, semi-shrubby chamaephyte. During winter, the buds are usually protected by water.

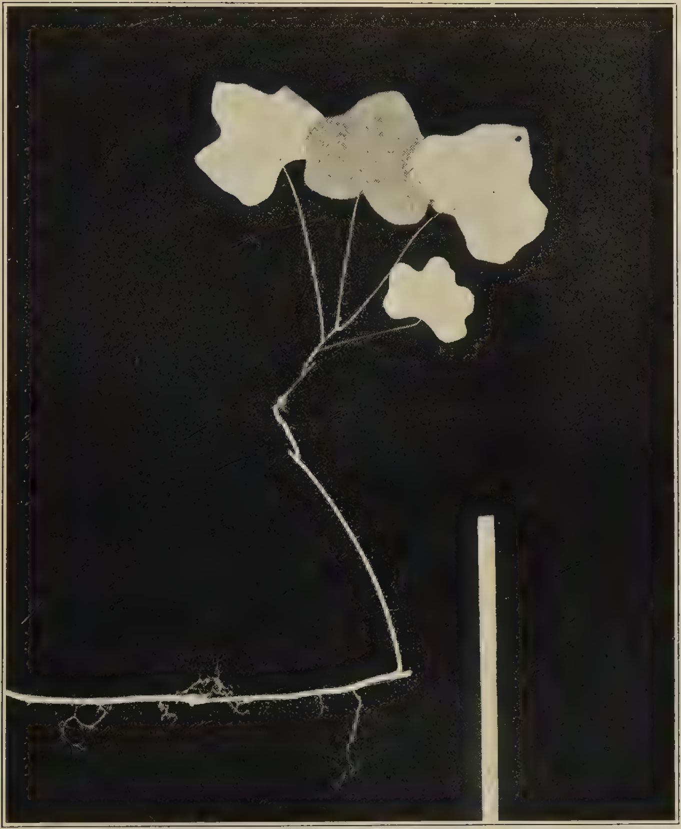

Fig. 4. Menispermum canadense, semi-shrubby chamaephyte.

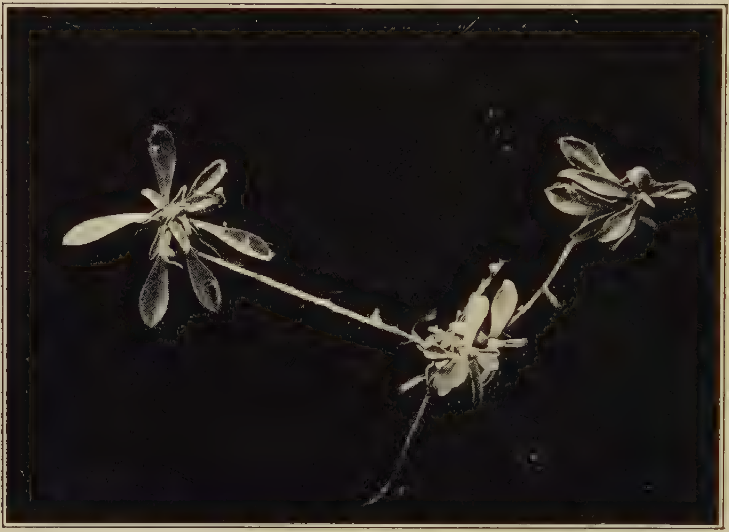

Fig. 5. Antennaria neglecta, passive chamaephyte. X ½

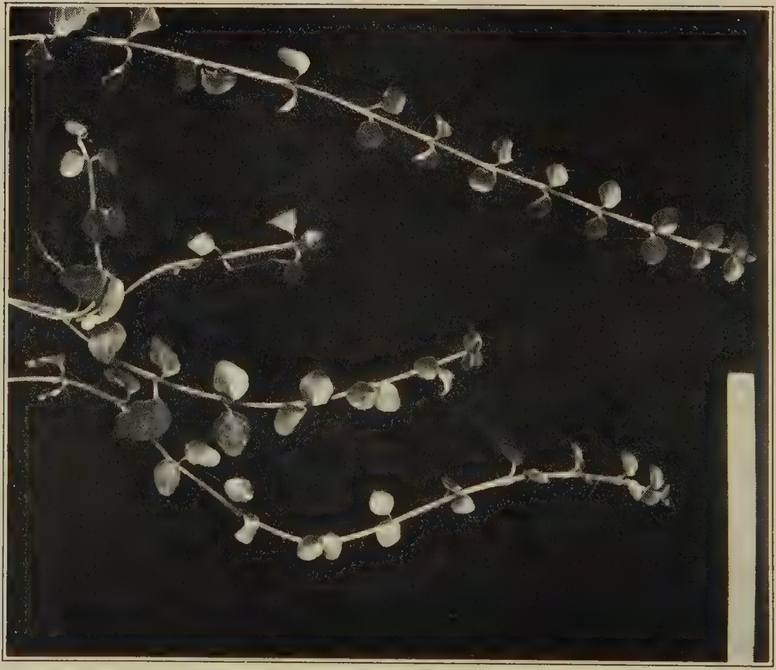

Fig. 6. Mitchella repens, active chamaephyte.

PLATE V.

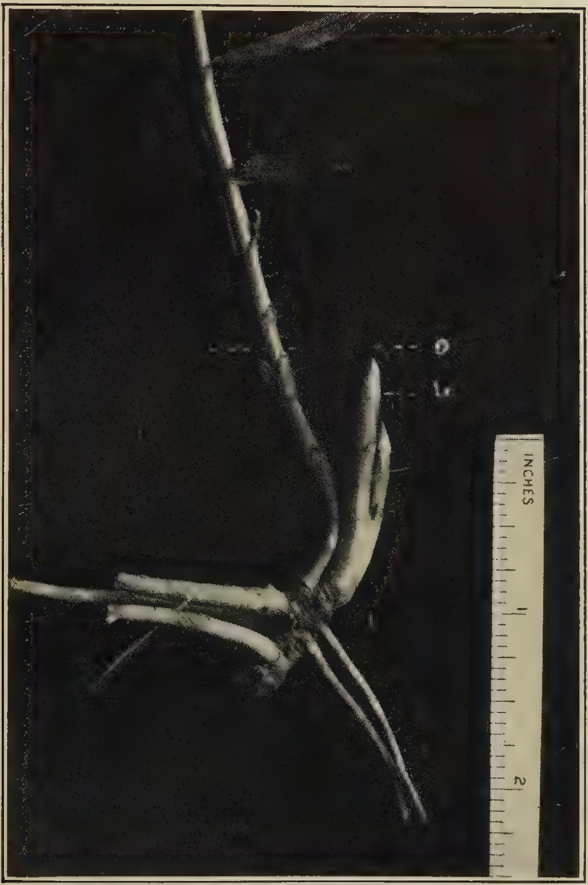

Fig. 7. Gentiana Andrewsii, protohemicryptophyte: b, perennating bud; o, surface of the ground.

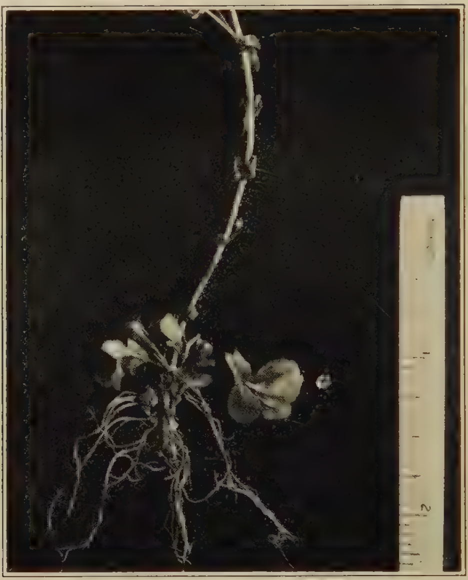

Fig. 8. Hypericum mutilum, protohemicryptophyte: o, surface of the ground.

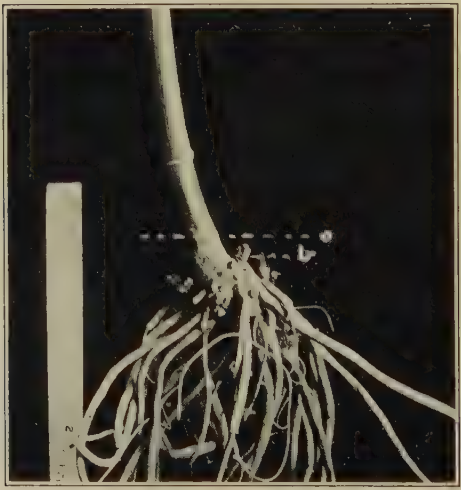

Fig. 9. Asclepias incarnata, protohemicryptophyte: b, perennating bud, o, surface of the ground.

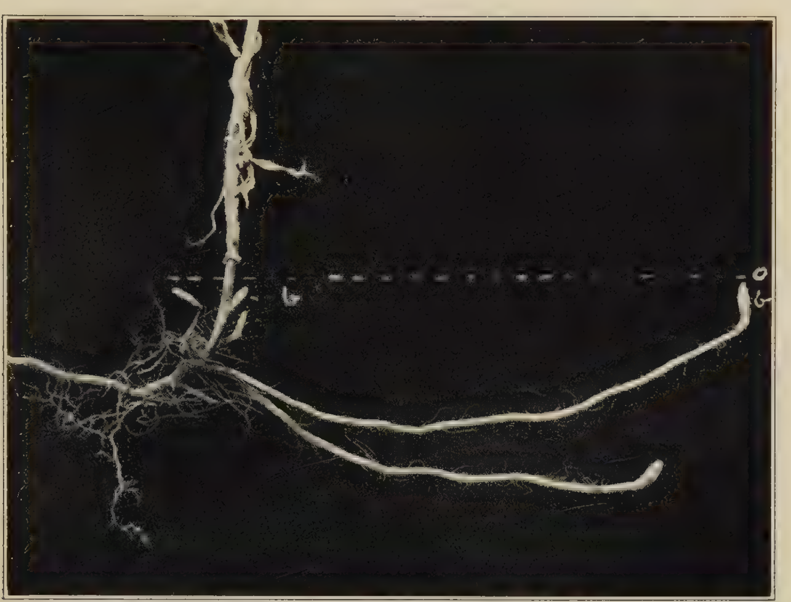

Fig. 10. Anaphalis margaritacea, protohemicryptophyte with running branches: b, perennating bud; o, surface of the ground. X ⅓.

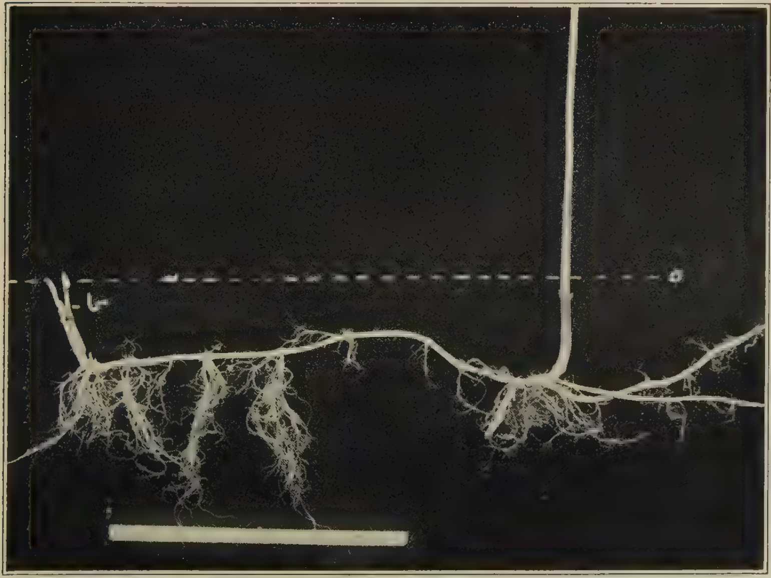

Fig. 11. Steironema ciliatum, protohemicryptophyte with running branches: b, perennating bud; o, surface of the ground.

PLATE VIII.

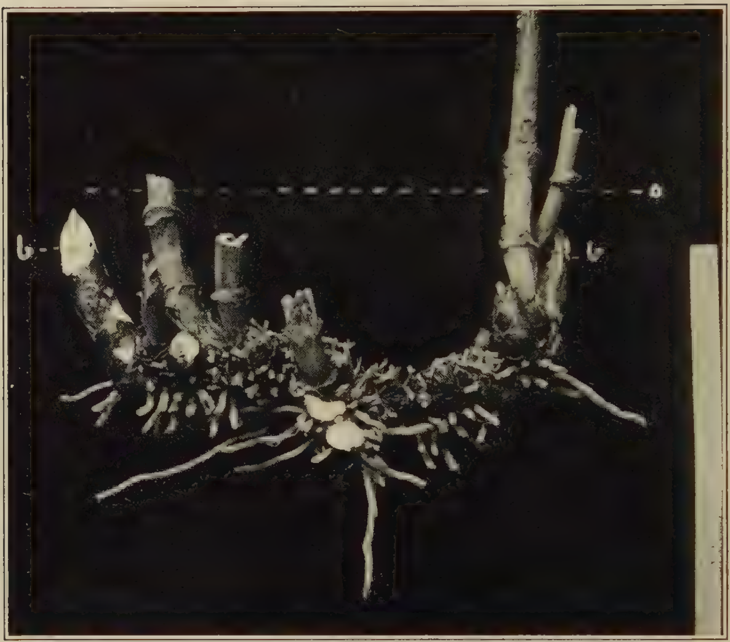

Fig. 12. Smilax herbacea, protohemicryptophyte with running branches: b, perennating bud; o, surface of the ground.

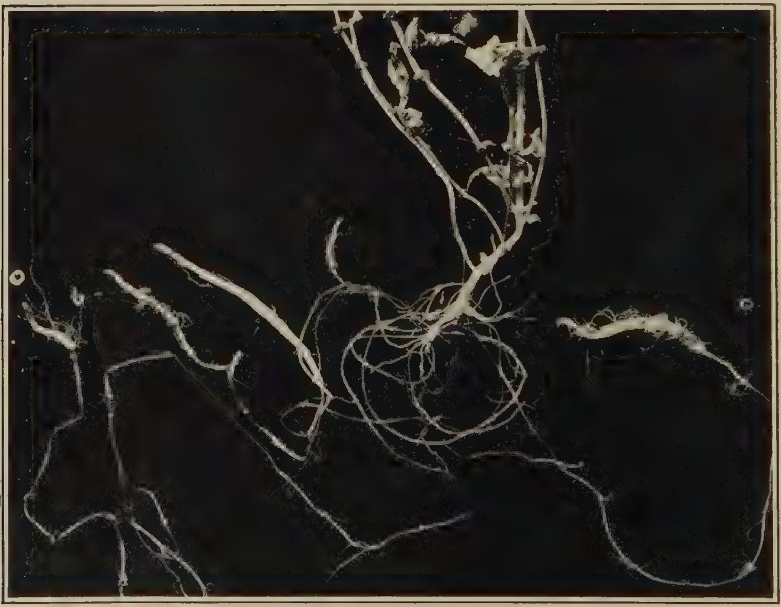

Fig. 13. Lycopus uniflorus, protohemicryptophyte with running branches. The stolons often come above ground, but they enter it again and form tuberous enlargements which bear buds at the surface. b, perennating bud; o, surface of the ground. X ⅓.

PLATE IX.

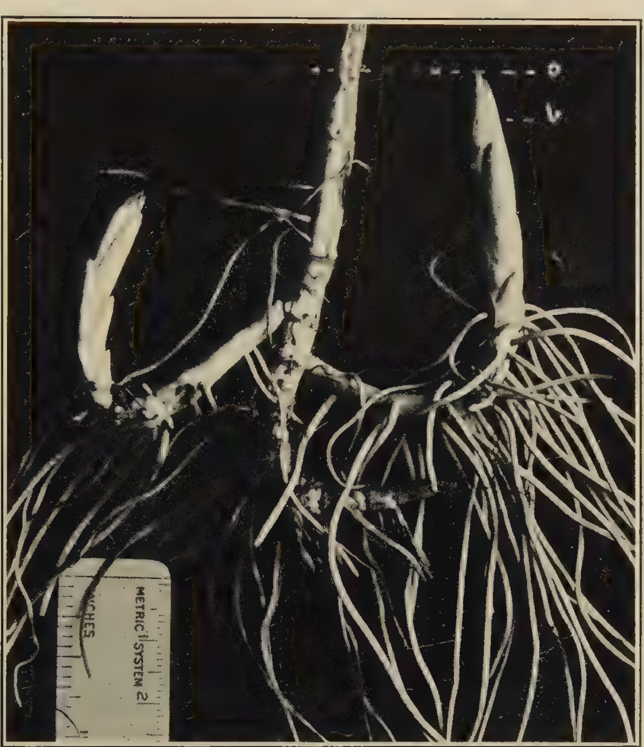

Fig. 14. Mimulus ringens, protohemicryptophyte with running branches: b, perennating bud; o, surface of the ground.

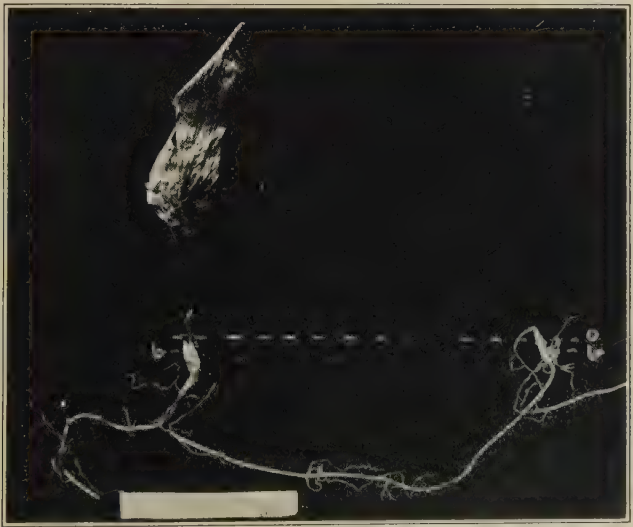

Fig. 15. Maianthemum canadense, protohemicryptophyte with running branches: b, perennating bud; o, surface of the ground.

PLATE X.

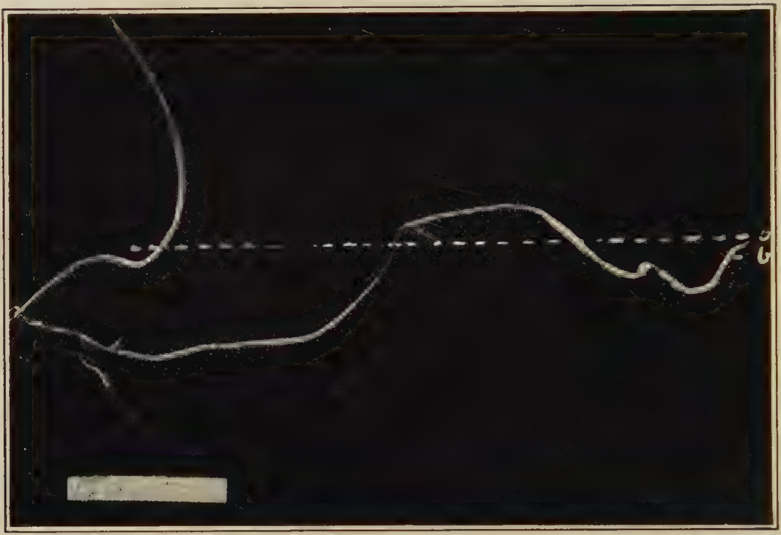

Fig. 16. Hypericum virginicum, protohemicryptophyte with running branches: b, perennating bud: o, surface of the ground.

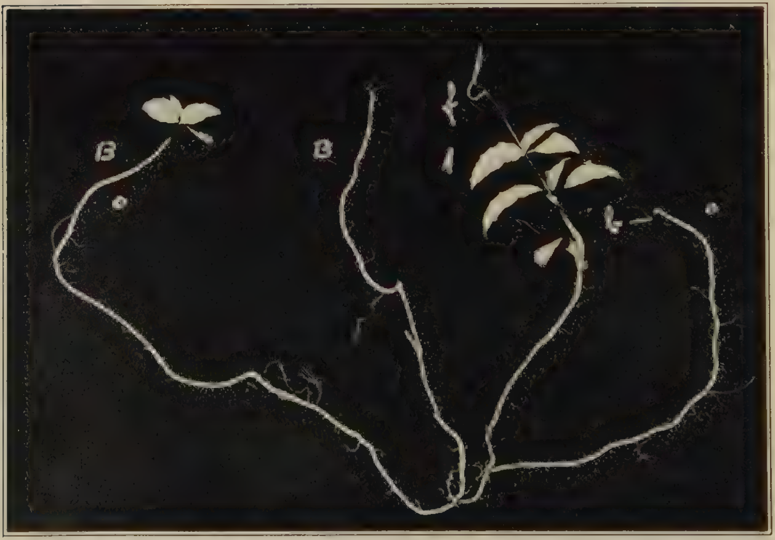

Fig. 17. Chimaphila maculata, evergreen protohemicryptophyte with running branches: A, mature plant with flowering stalk (f); B, young plant which will bear flowering stalk next season; b, perennating bud which will produce a young plant next season; o, surface of the ground. X ⅓.

PLATE XI.

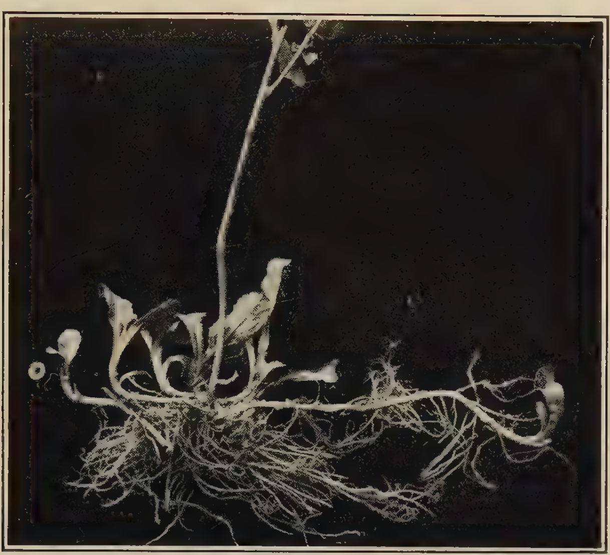

Fig. 18. Solidago, hemicryptophyte semi-rosette plant with running branches: o, surface of the ground.

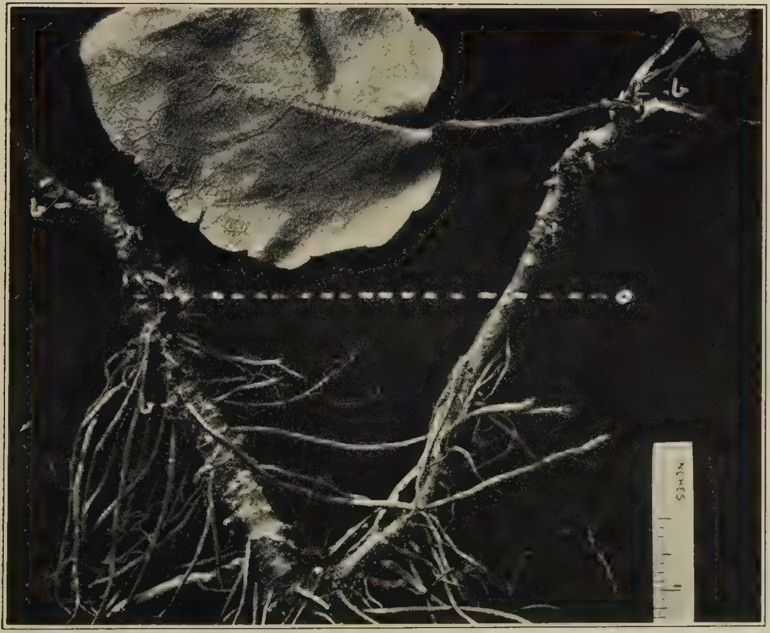

Fig. 19. Aster macrophyllus, hemicryptophyte semi-rosette plant with running branches: b, perennating bud: o, surface of the ground. When the buds which are above ground-level survive, this plant conducts itself as a chamaephyte.

PLATE XII.

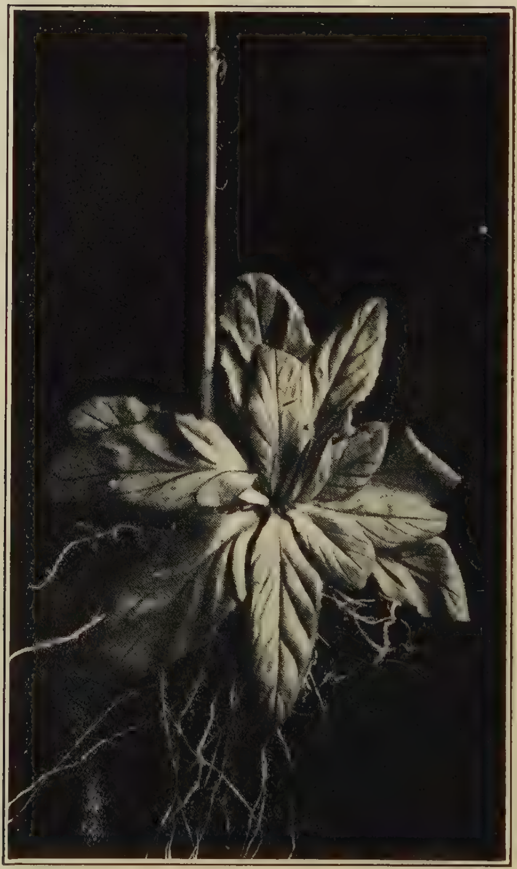

Fig. 20. Epilobium adenocaulon, hemicrpytophyte semi-rosette plant.

PLATE XIII.

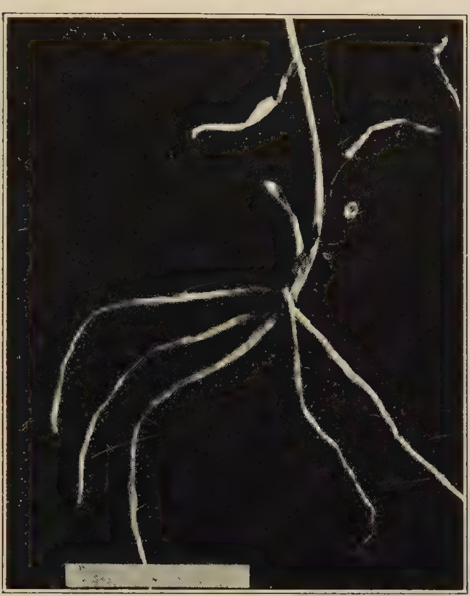

Fig. 21. Spiranthes cernua, hemicryptophyte semi-rosette plant: o, surface of the ground.

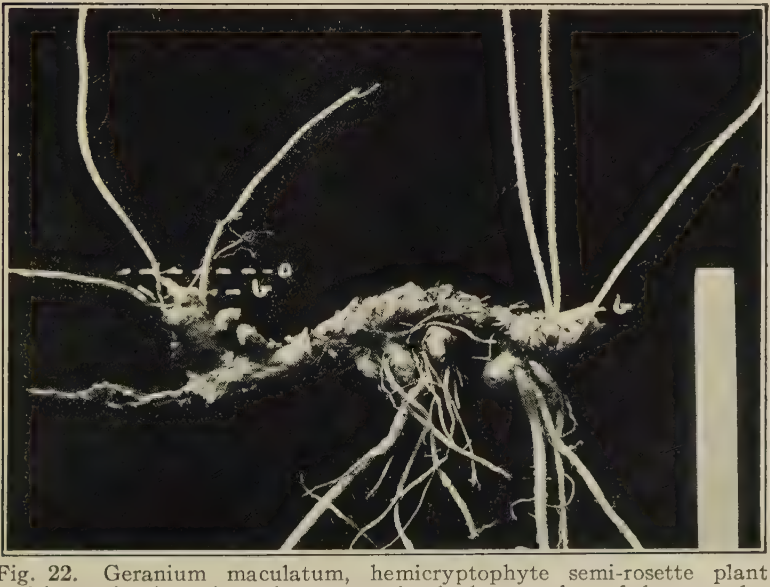

Fig. 22. Geranium maculatum, hemicryptophyte semi-rosette plant with running branches: b, perennating bud; o, surface of the ground.

PLATE XIV.

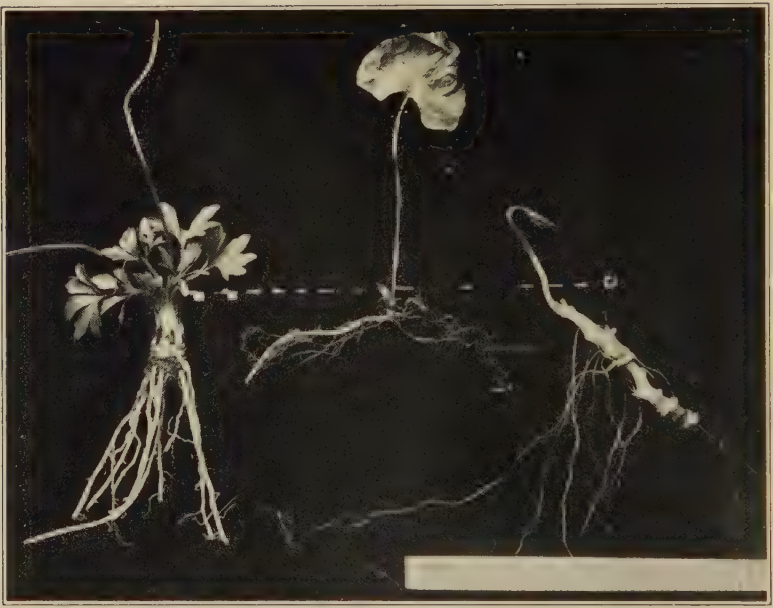

Fig. 23. Viola spp., hemicryptophyte semi-rosette plants with running branches: o, surface of the ground.

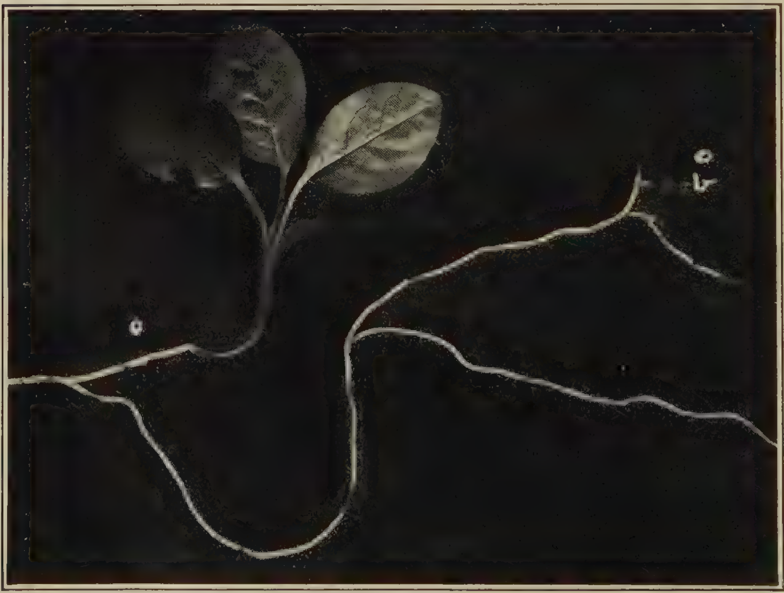

Fig. 24. Pyrola elliptica, evergreen hemicryptophyte rosette plant with running branches: b, perennating bud; o, surface of the ground. X ½.

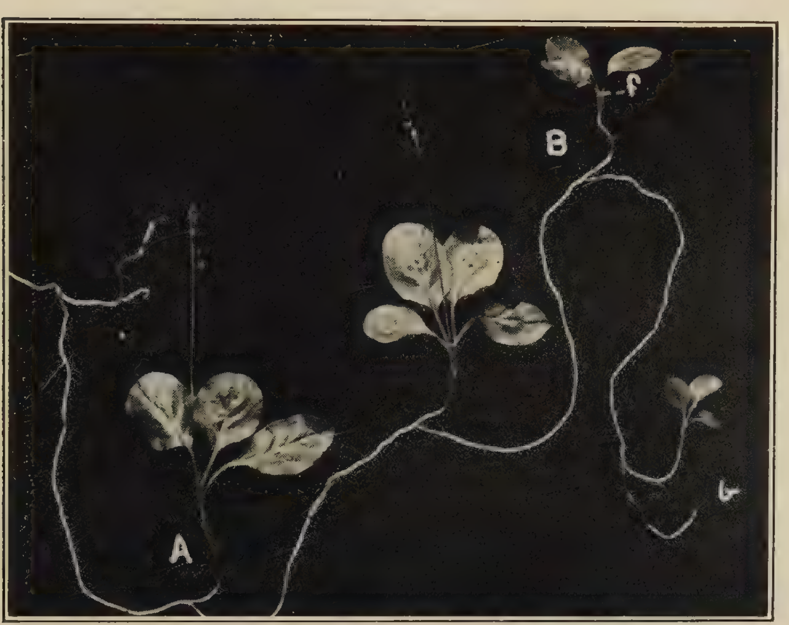

Fig. 25. Pyrola elliptica, evergreen hemicryptophyte rosette plant with running branches: A, mature plants bearing flowering stalks; B, young plants bearing flower buds (f); b, perennating bud borne at the surface of the ground. X ⅓.

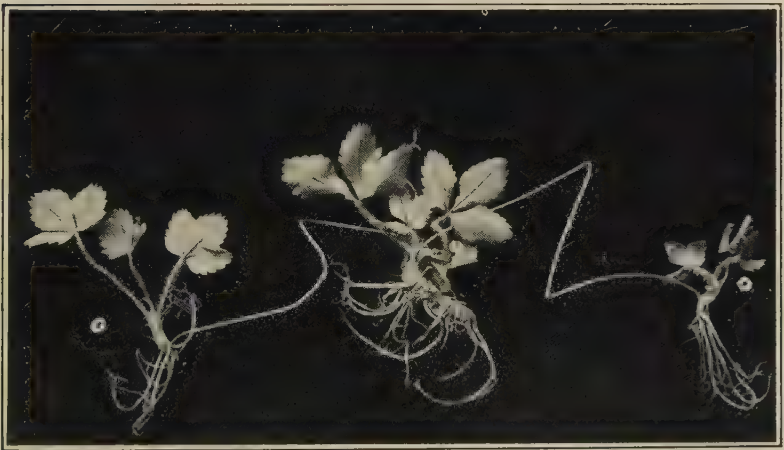

Fig. 26. Fragaria virginiana, hemicryptophyte rosette plant with running branches: o, surface of the ground. X ⅓.

PLATE XVI.

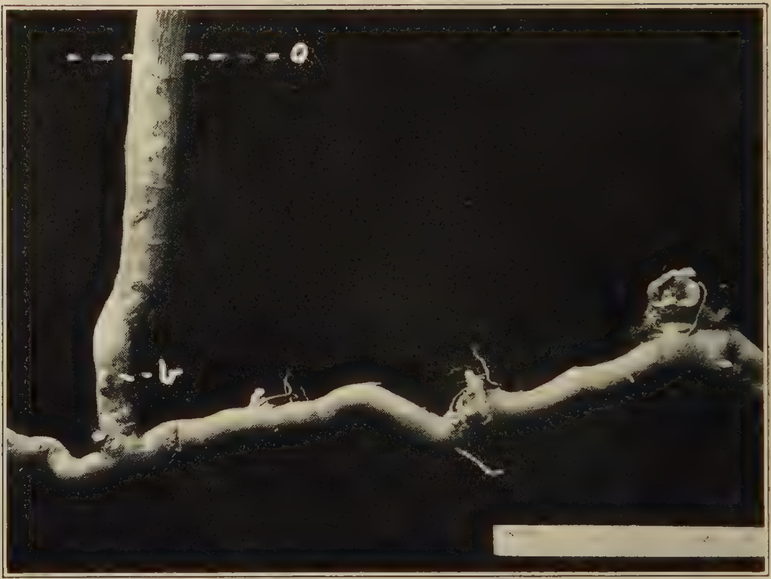

Fig. 27. Asclepias syriaca, rhizome geophyte: b, perennating bud; o, surface of the ground.

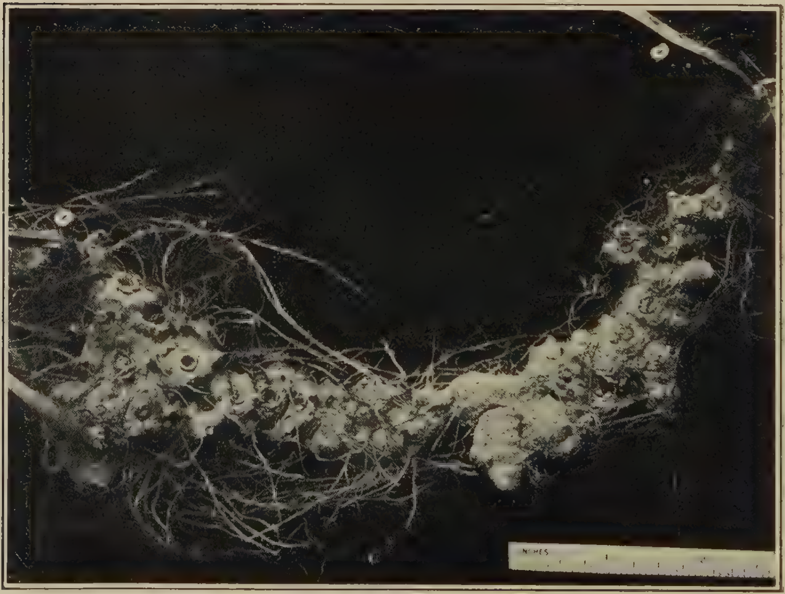

Fig. 28. Collinsonia canadensis, rhizome geophyte: o, surface of the ground.

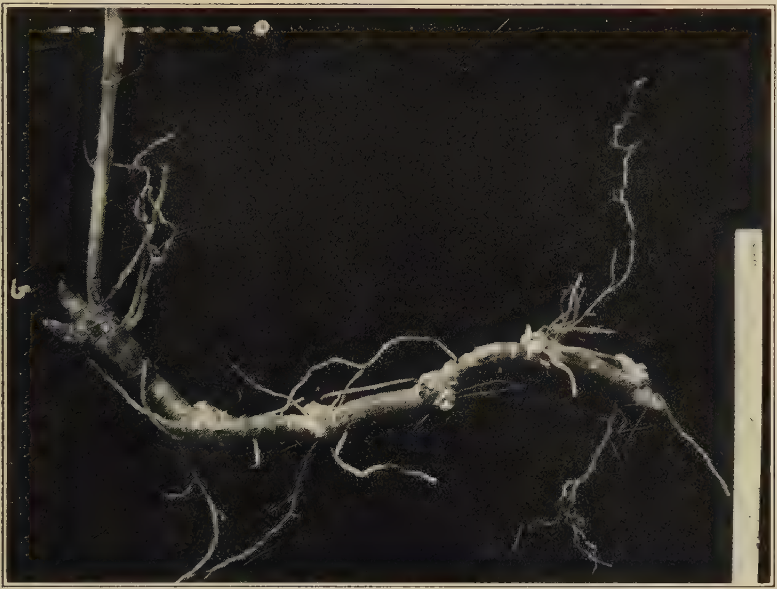

Fig. 29. Smilacina racemosa, rhizome geophyte: b, perennating bud: o, surface of the ground.

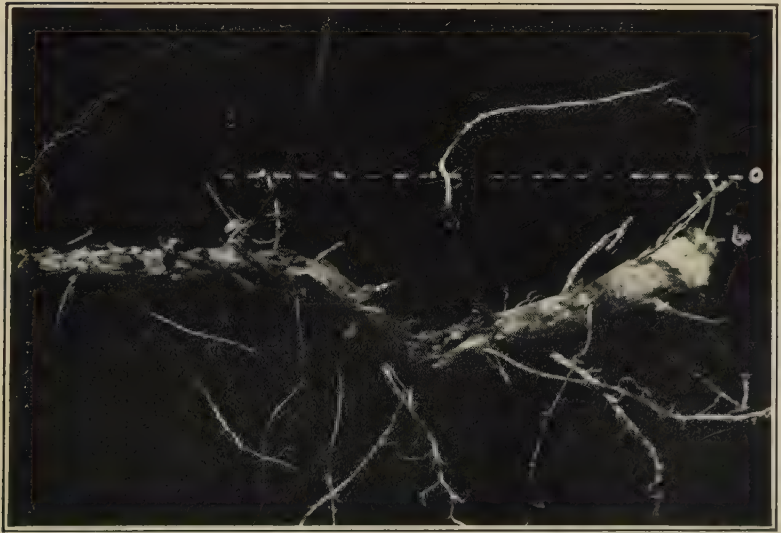

Fig. 30. Dioscorea villosa, rhizome geophyte: b, perennating bud; o, surface of the ground.

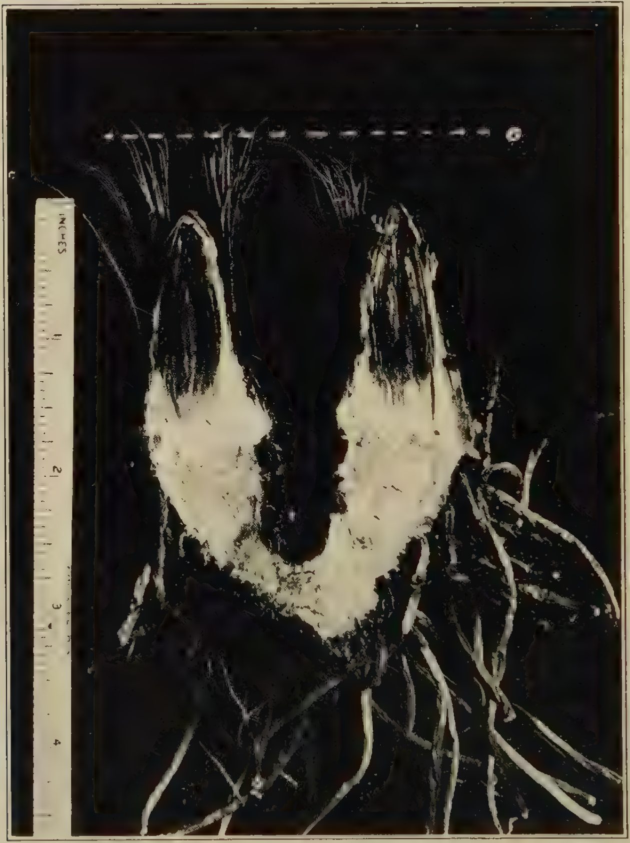

Fig. 31. Veratrum viride, rhizome (bulb) geophyte: o, surface of the ground.

PLATE XIX.

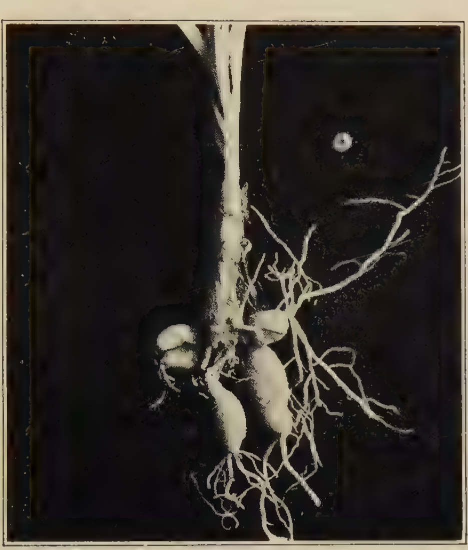

Fig. 32. Hemerocallis fulva, root tuber geophyte: o, surface of the ground. X ½.

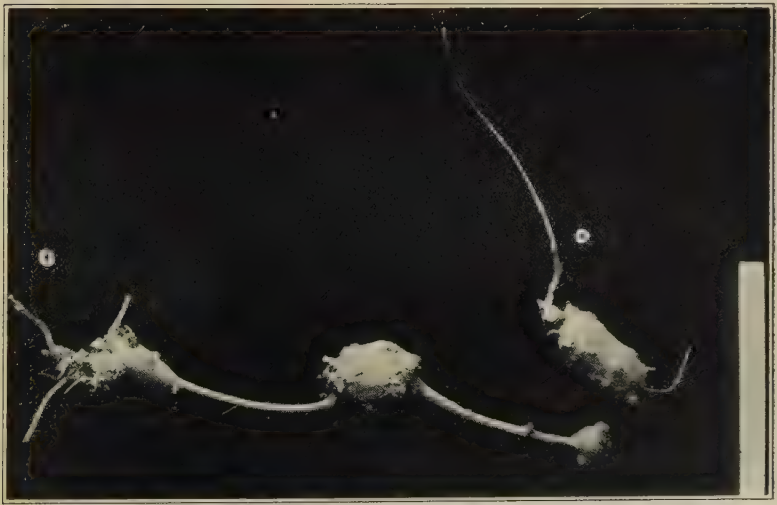

Fig. 33. Apios tuberosa, stem tuber geophyte: o, surface of the ground.

PLATE XX.

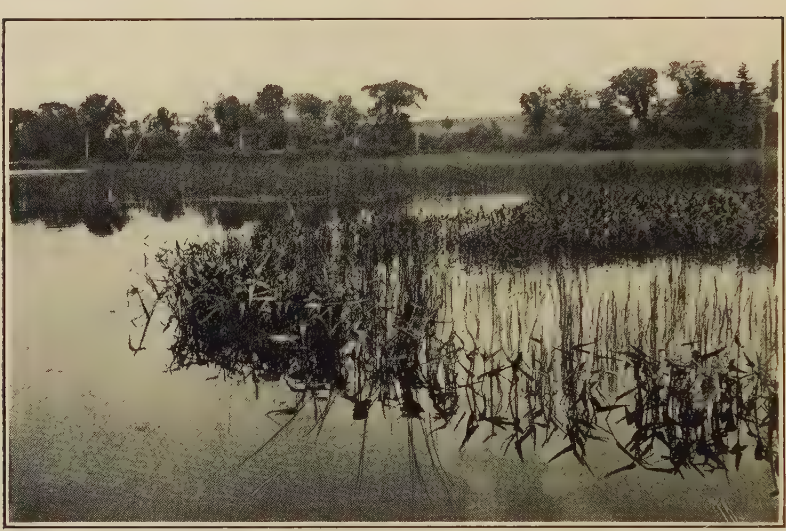

Fig. 34. Pontederia cordata, helophyte. Scirpus validus in the background.

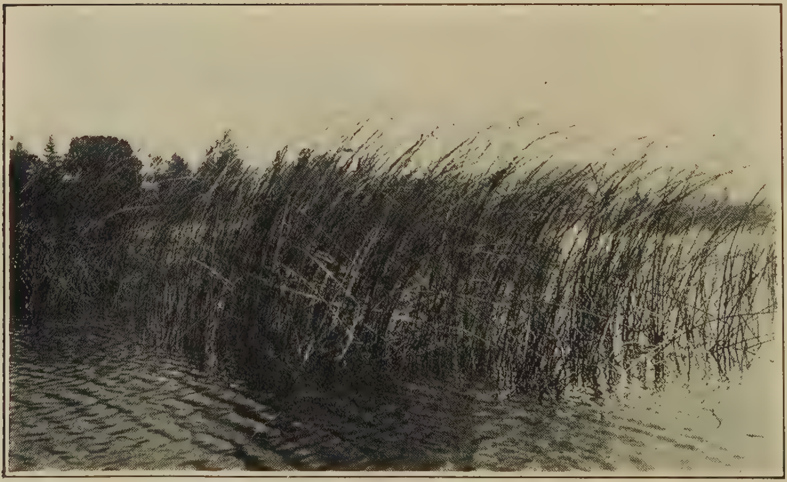

Fig. 35. Scirpus validus, helophyte.

BULLETINS

OF THE

State Geological and Natural History Survey of Connecticut

1. First Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1903-1904; 18 pp., 23 cm., 1904.

2. A Preliminary Report on the Protozoa of the Fresh Waters of Connecticut: by Herbert William Conn, Ph.D.; 69 pp., 34 pls., 23 cm., 1905. (*Out of print as a separate bulletin. To be obtained only in Vol. I, containing Bulletins 1-5. Price $1.75 postpaid.*)

3. A Preliminary Report on the Hymeniales of Connecticut: by Edward Albert White, B.S.; 81 pp., 40 pls., 23 cm., 1905. (*Out of print as a separate bulletin. To be obtained only in Vol. I, containing Bulletins 1-5. Price $1.75 postpaid.*)

4. The Clays and Clay Industries of Connecticut: by Gerald Francis Loughlin, S.B.; 121 pp., 13 pls., 23 cm., 1905.

5. The Ustilagineae, or Smuts, of Connecticut: by George Perkins Clinton, S.D.; 45 pp., 55 figs., 23 cm., 1905.

6. Manual of the Geology of Connecticut: by William North Rice, Ph.D., LLD., and Herbert Ernest Gregory, Ph.D.; 273 pp., 31 pls., 22 figs., (10 maps) 23 cm., 1906. (*Out of print as a separate bulletin. To be obtained only in Vol. II, containing Bulletins 6-12. Price $2.75 Postpaid.*)

7. Preliminary Geological Map of Connecticut: by Herbert Ernest Gregory, Ph.D., and Henry Hollister Robinson, Ph.D.; 39 pp., 2 maps (1 in pocket), 23 cm., 1907. (*Out of print as a separate bulletin. To be obtained only in Vol. II, containing Bulletins 6-12. Price $2.75, postpaid.*)

8. Bibliography of Connecticut Geology: by Herbert Ernest Gregory, Ph.D.; 123 pp., 23 cm., 1907.

9. Second Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1905-1906; 23 pp., 23 cm., 1906.

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